THE

HAWAIIAN PLANTERS' RECORD

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A monthly paper devoted to the sugar interests of Hawaii and issued by the Experiment Station for circulation among the plantations of the Hawaiian Sugar Planters' Association

Backed by Capital, Guided by Science.

"Discontent, properly directed, is a great constructive force. Only when no way seems open for its relief, does it become destructive. It should therefore be made convincingly clear to labor that the maintenance of its present returns and the satisfaction of its prospective demands are possible only by raising the productive power of the individual. Wealth which is nonexistent cannot be divided. Our estate contains resources abundantly ample for all legitimate satisfactions of a population many times as numerous as that which it now supports. But undeveloped resources are not wealth. They were here with the Indians. Their potentialities can be realized, not by labor alone, not by capital alone, not by labor and capital together, unless through the cooperation of the executive brain and science. The war has at last placed science above the salt, even at bankers' dinners. It has penetrated the Privy Council. Chemistry is saluted by the man in the street, and chemists are putting the dollar sign in their equations. * * *

"Increased production does not mean, for the individual, more work or harder work. It does mean more efficient work and a new attitude toward work: the desire to make every stroke tell to the utmost. It means gang-plowing with a tractor, intensive truck-farming, growing beets which yield twelve per cent of sugar instead of eight, grinding with carborundum, cutting deep into the metal with tools of high-speed steel. It means microscopes and pyrometers, slide-rules and graphic charts, recording

instruments, wise planning, and the laboratory control of materials and processes. In a word, it means willing, painstaking, and well-paid effort, backed by capital, guided by science."—*From "Developing the Estate," by Arthur D. Little, The Atlantic Monthly for March,* 1919.

Sugar Cane—Its Cost of Production.

We invite the attention of the plantation overseers and field men to something we have to say to them:—

We want to become better acquainted with you—we want to know more about the work you are doing, and want you to know more about the work we are doing.

There is a great deal to be gained if you will devote yourself to an intimate study of the cost of production. We believe the plantation overseer should see dollar-and-cents marks wherever he goes about the plantation. If the Hawaiian scenery suffers in consequence, we submit as a substitute the fascinating source of interest you will find in going into the fine points of cost figures.

Do you know what the fertilizer costs?

Do you know what it costs per unit of nitrogen?

Do you know how many pounds of sugar you produce per pound of nitrogen applied to the soil?

Do you know that the yields can be increased by increasing the applications of nitrogen?

Do you know that in raising the production per acre you lower the cost of production per ton?

These are things you should be familiar with.

We believe that the day is coming when the more progressive plantations will employ overseers and agriculturists who have qualifications corresponding to those of officers in the American army. The lieutenant of a machine-gun company had to know the machine gun, every part of it. The overseer who has charge of fertilizing should know fertilizers, from start to finish.

We want to help the present plantation overseers to prepare themselves for these positions on the more progressive plantations of tomorrow—and help them to get the higher pay such jobs are worth.

If you want to know what a unit of nitrogen is, if you want to

know the difference between nitrogen and nitrate of soda, if you want to know how many pounds of sugar result from an added pound of nitrogen, under various conditions,—write to us and find out.

Our files, our library, our services, are available to every man employed on an H. S. P. A. plantation, and always have been, but not many, except the managers and the chemists, take advantage of this fact.

There are lots of things the Station does not know about sugar cane, lots of things we are trying to find out, lots of things you can tell us; but if we have any information you want, it is yours. So let us hear from you. (We do not correspond with anyone on any plantation without sending a copy of our letter to the manager. This is right. He should know what we have to say to the men who work with him.) If enough of you want it we are prepared to consider a course by correspondence or a short course in agriculture (lasting two weeks in the off-season)—such a course as you would have the opportunity to take advantage of if you were farming in any State of the Union—and through which we would endeavor to acquaint you with the fundamental facts and principles that might aid you in applying the scientific knowledge of the world to the sugar industry for which you work.

There is nothing mysterious about science—there is no real difference between scientific agriculture and practical agriculture, for scientific agriculture is the most practical agriculture there is. Scientific agriculture is agriculture which is practised with a knowledge of the underlying facts pertaining to the soils, the plants, and the materials with which we work. Science is to agriculture what light would be to a poorly illuminated place in which you have an intricate piece of work to do. Science is truth, information; nothing more, nothing less. You usually associate science with microscopes, latin names, and laboratories, but these things are only a means to an end. We will not have scientific agriculture in the highest sense, until the men of the laboratories recognize what they have to learn from you men in the field, and you men in the field recognize what you have to learn from the men of the laboratories and the experiment plats. This does not mean that they must do your work or you do theirs, but each should have a better understanding of the work of the other.

Our big job, yours and ours, is to "clear decks and close in" (as a fleet does before an engagement)—build up the agriculture of these Islands—make ready to meet the foreign competition

which is going to make Hawaii work to hold her place in the sugar world of tomorrow.

It is a big enough job to occupy the energy and thought of every man in the Islands, and it has possibilities that are interesting enough to repay each of them for all he puts into it.

The War is over. The new era is here. Are you going to *live* in it, or are you going to be a hang-over from pre-war conditions?

THE KOHALA FOREST.

The four photographs reproduced herewith were taken by Mr. Agee during a visit to the Halawa-Niulii forest area last Fall.

These pictures show the conditions now existing in the Kohala forest above the mauka fence of Halawa-Niulii reserve. The dead forest shown in Fig. 1 was included in an area marked

Fig. 1. The "dense forest" of a few years ago.

"dense forest" on a map prepared by Mr. Hosmer in 1911. Judging from the remains, it was a "dense forest" only a very few years ago.

At many points the conditions within the Halawa-Niulii forest reserve are little better than those on the ranch lands above. Fig. 4 shows the pasture lands on the right of the fence and the forest reserve on the left. The horses are grazing in the reserve.

Fig. 2. Dead Ohia trees.

Fig. 3. All trees eventually succumb.

Fig. 4. Looking along the fence line which separates the ranch and the forest reserve.

THE PROFITABLE LIMIT OF FERTILIZATION.

Honomu Experiment No. 1, 1919 Crop.*

The object of this test was to determine the profitable limit of fertilization. We also tested the value of supplementary applications of phosphoric acid.

SUMMARY.

The plan of fertilization was as follows:

Plots	June, 1917	Sept., 1917	Jan., 1918	May, 1918	July, 1918	Total Lbs. Nitrogen per Acre	Lbs. Phosphoric Acid per Acre
A	136.3 lbs. M. F.	136.3 lbs. M. F.	136.3 lbs. M. F.	85.7 lbs. N. D.	85.7 lbs. N. D.	75	33
B	272.7 lbs. M. F.	272.7 lbs. M. F.	272.7 lbs. M. F.	171.4 lbs. N. D.	171.4 lbs. N. D.	150	66
C	409.0 lbs. M. F.	409.0 lbs. M. F.	409.0 lbs. M. F.	257.1 lbs. N. D.	257.1 lbs. N. D.	225	98
D	545.4 lbs. M. F.	545.4 lbs. M. F.	545.4 lbs. M. F.	342.8 lbs. N. D.	342.8 lbs. N. D.	300	131
E	681.8 lbs. M. F.	681.8 lbs. M. F.	681.8 lbs. M. F.	428.5 lbs. N. D.	428.5 lbs. N. D.	375	164
F	818.1 lbs. M. F.	818.1 lbs. M. F.	818.1 lbs. M. F.	514.2 lbs. N. D.	514.2 lbs. N. D.	450	196

* Experiment originally laid out by L. D. Larsen.
Harvested by Grant and Pahau.

Phosphoric Acid Test. For the 1917 crop, Plots 1 to 6 inclusive, 13 to 18 inclusive, 25 to 30 inclusive, and 37 to 42 inclusive received an application of acid phosphate at the rate of 2000 lbs. per acre in addition to the regular fertilization as indicated above.

The mixed fertilizer (M. F.) was of the following composition: 11% nitrogen, 8% phosphoric acid. The nitrogen dressing contained 17.5% nitrogen.

The cane involved was Yellow Caledonia, third ratoons, at an elevation of about 1000 feet. The field has been in cane continuously for 25 years.

There were eight repetitions of each treatment in 1/16-acre plots.

The results show a gain of about half a ton of sugar per acre for each 75 pounds of nitrogen (obtained from 409 pounds of mixed fertilizer and 171 pounds of nitrogen dressing) up to an application of 300 pounds of nitrogen per acre. Larger amounts of fertilizer than this did not pay. Three hundred pounds of nitrogen per acre is well above the fertilizer practice of these Islands.

The results of the test follow:

Plots	Pounds of Nitrogen per Acre	YIELD PER ACRE		
		Cane	Q. R.	Sugar
A	75	36.4	8.14	4.47
B	150	41.2	8.42	4.89
C	225	47.5	8.72	5.45
D	300	51.9 ~~[illegible]~~	8.68	5.98
E	375	52.8	8.78	6.02
F	450	53.7	9.42	5.70

The quality of juices was consistently in an inverse ratio to the amounts of fertilizer applied, there being a difference of 1.28 in the quality ratio between the A plots, with 75 pounds of nitrogen per acre, and F plots, with 450 pounds of nitrogen per acre.

This experiment is a repetition, with certain modifications, of Honomu Experiment No. 1, 1917 Crop.* We find a marked similarity in the results as obtained in both these two experiments in that up to an application of 300 pounds of nitrogen per acre there was a gradual and steady gain in sugar. The chart (Fig. 2) is reprinted to show this.

In the 1917 crop, as 300 pounds of nitrogen was the maximum application, we did not know how much higher the yields would go with a continued increase in fertilization.

By these two experiments we have demonstrated that a maximum application of 300 lbs. of nitrogen can be made

* Reported in the Record, Vol. XVI, No. 4, page 280.

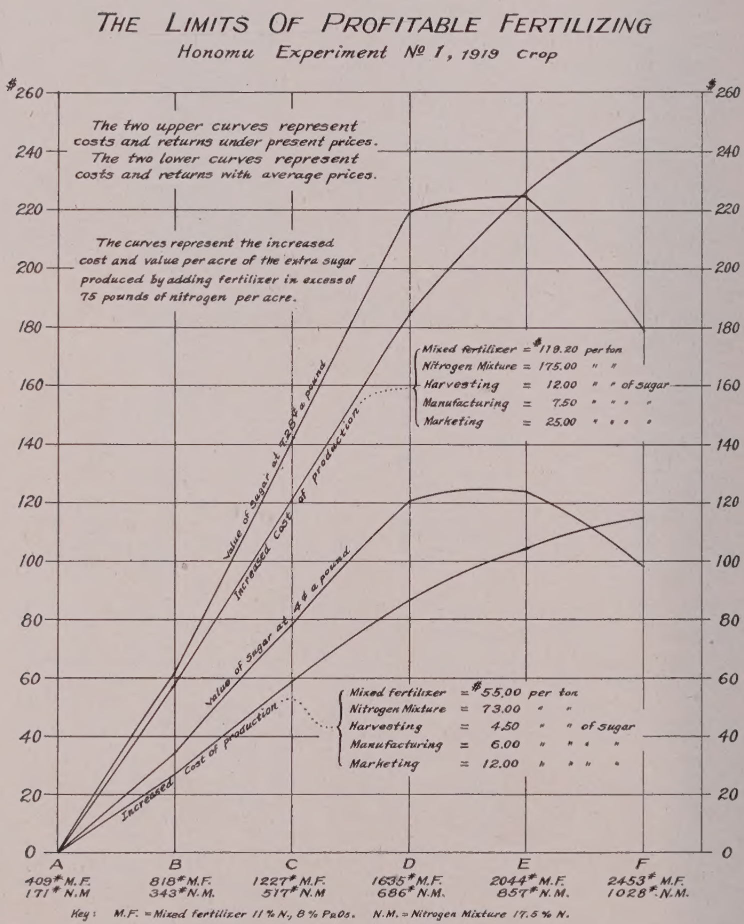

THE LIMITS OF PROFITABLE FERTILIZING
Honomu Experiment No. 1, 1919 Crop
The two upper curves represent costs and returns under present prices.
The two lower curves represent costs and returns with average prices.
The curves represent the increased cost and value per acre of the extra sugar produced by adding fertilizer in excess of 75 pounds of nitrogen per acre.
Value of Sugar at 7.28¢ a pound
Increased Cost of production
Value of Sugar at 4¢ a pound
Increased Cost of production
Mixed fertilizer = $119.20 per ton
Nitrogen Mixture = 175.00 " "
Harvesting = 12.00 " " of sugar
Manufacturing = 7.50 " " "
Marketing = 25.00 " " "
Mixed fertilizer = $55.00 per ton
Nitrogen Mixture = 73.00 " "
Harvesting = 4.50 " " of sugar
Manufacturing = 6.00 " " "
Marketing = 12.00 " " "
$260
240
220
200
180
160
140
120
100
80
60
40
20
0
A
409# M.F.
171# N.M
B
818# M.F.
343# N.M.
C
1227# M.F.
517# N.M
D
1635# M.F.
686# N.M.
E
2044# M.F.
857# N.M.
F
2453# M.F.
1028# N.M.
Key: M.F. = Mixed fertilizer 11% N., 8% P2O5. N.M. = Nitrogen Mixture 17.5% N.

Fig. 1.

with profit under conditions prevailing at Honomu Sugar Co. with ratoon cane.

In the cut shown in Fig. 1 an attempt was made to show the profits or losses per acre for the different fertilizer treatments in this experiment under different market conditions.

It is interesting to note that for the optimum fertilization—that is, 300 pounds nitrogen per acre—the profits per acre are almost identical under pre-war or present conditions, showing

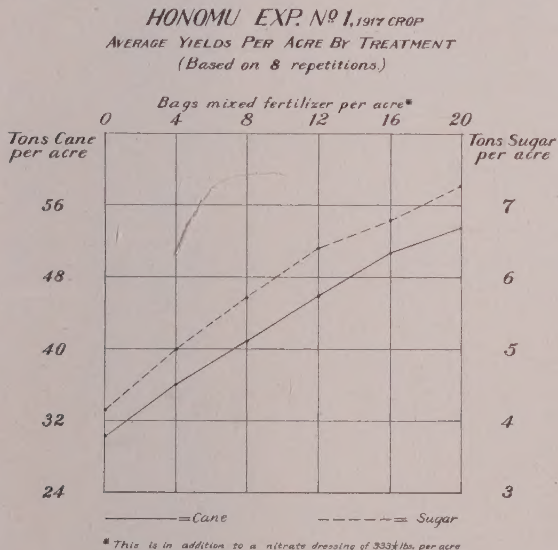


Fig. 2.

that present sugar prices about make up for increased cost of fertilizing.

The additional phosphoric acid applied in 1917 had no residual effect whatever on the yields. The following table gives the yields from the phosphate and no-phosphate plots:

Plots	No. of Plots	Brix	Sucrose	Purity	Q. R.	Yield per Acre Tons Cane	Yield per Acre Tons Sugar
			PHOSPHATE.				
A	4	19.04	16.61	87.2	8.04	38.58	4.80
B	4	18.47	15.46	83.7	8.76	41.98	4.79
C	4	17.87	15.18	84.9	8.85	48.05	5.43
D	4	17.53	14.80	84.4	9.11	52.90	5.81
E	4	18.01	15.17	84.2	8.91	52.76	5.92
F	4	17.94	14.81	82.6	9.21	52.86	5.74
Average	....	18.11	15.34	84.5	8.73	47.85	5.48

NO PHOSPHATE.

A	4	18.74	16.11	86.0	8.34	34.19	4.10
B	4	19.00	16.44	86.5	8.12	40.33	4.97
C	4	18.20	15.59	85.7	8.60	47.01	5.47
D	4	18.70	16.11	86.1	8.27	50.98	6.16
E	4	18.17	15.49	85.3	8.66	52.87	6.11
F	4	17.27	14.21	82.3	9.62	54.49	5.66
Average	....	18.35	15.66	85.3	8.57	46.65	5.44

DETAILS OF EXPERIMENT.

Object.

1. To determine the limit of profitable fertilization under conditions that obtain in the upper fields at Honomu on Yellow Caledonia ratoons.

2. To determine the residual effect of a supplementary dose of phosphoric acid.

Location.

Honomu Sugar Co., Field 6 B, on both sides of the plantation road that runs through the middle of the field.

Plan.

Number of plots: 48.
Size of plots: 1/16 acre, each consisting of 5 lines, 95′ long and 3⅜′ wide.

Fertilization.

POUNDS NITROGEN PER ACRE.

Plots	No. of Plots	As M. F., June 15, '17	As M. F., Sept. 15, '17	As M. F., Jan. 15, '18	As N. D., May 30, '18	As N. D., July 15, '18	Total
A	8	15	15	15	15	15	75
B	8	30	30	30	30	30	150
C	8	45	45	45	45	45	225
D	8	60	60	60	60	60	300
E	8	75	75	75	75	75	375
F	8	90	90	90	90	90	450

M. F. = Mixed fertilizer (B-5):
11% Nitrogen (5% nitrogen soda, 5% sulphate amm., 1% organic).
8% Phosphoric Acid (5% bone meal, 3% super-phosphate).

N. D. = Nitrogenous Dressing (C-1):
17.5% Nitrogen (8.75% nitrate soda, 8.75% sulphate amm.).

Phosphoric Acid Test. For the 1917 crop, plots 1 to 6 inclusive, 13 to 18 inclusive, 25 to 30 inclusive, and 37 to 42 inclusive

received an application of acid phosphate at the rate of 2000 pounds per acre (21.95% P_2O_5), in addition to the regular fertilization.

Chronological Data.

February 12-14, 1917, previous crop harvested.
June 5, 1917, experiment fertilized.
September 27, 1917, experiment fertilized.
January 25, 1918, experiment fertilized.
May 18, 1918, experiment fertilized.
July 20, 1918, experiment fertilized.
February 13, 1919, experiment harvested.

J. A. V.

Fig. 1. Honomu Experiment 1, Plot 1A. August 13, 1917. This plot received no fertilizer during 1917 crop. and on June 7, 1917, received 136.3 lbs. per acre of B5 for the 1919 crop. The stand and growth is very poor. The cane has been growing for six months, being harvested February 14, 1917. Height of camera, 3.6 ft.; distance from object, 25 ft.

Fig. 2. Honomu Experiment 1, Plot 6F. August 13, 1917. This plot received 20 bags of mixed fertilizer during the 1917 crop and 818 lbs. per acre of B5 fertilizer on June 7, 1917, for the 1919 crop. The stand and growth is excellent. The cane has been growing for six months, being harvested February 14, 1917. Height of camera, 3.6 ft.; distance from object, 25 ft.

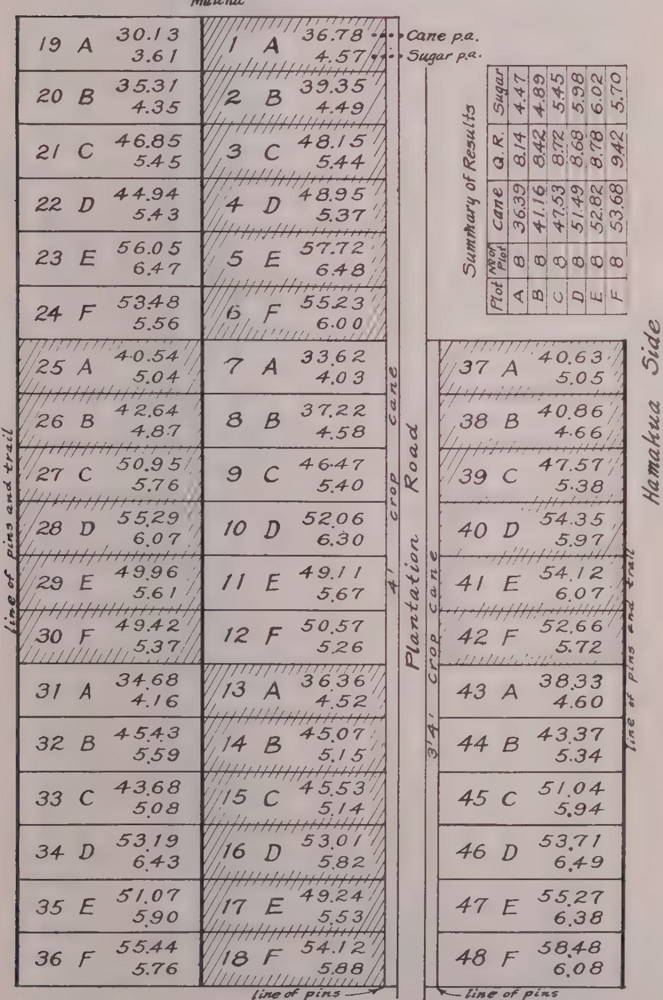
PLAN OF EXPERIMENT & YIELD PER ACRE

HONOMU EXP. No. 1, 1919 CROP

Field 6 B

48 plots, each ⅛ acre consisting of 5 lines. 5⅜' wide & 95' long.

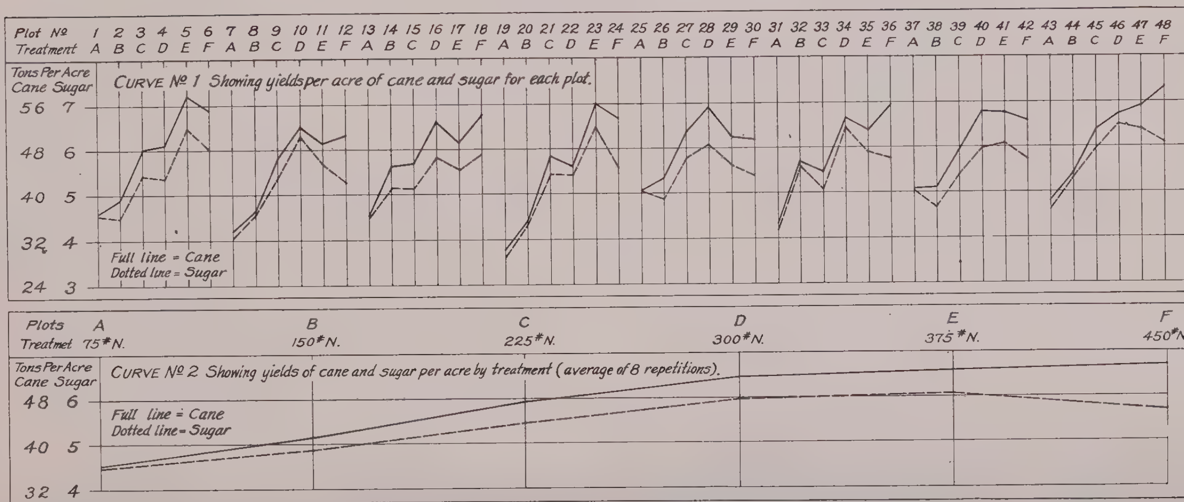
Key: Shaded area = Acid phosphate at the rate of 2000# per acre (21.95% P_2O_5) applied preceeding crop.
Clear area = No phosphoric acid



Summary of Results

Plot	No. of Plot	Cane	Q.R.	Sugar
A	8	36.39	8.14	4.47
B	8	41.16	8.42	4.89
C	8	47.53	8.72	5.45
D	8	51.49	8.68	5.98
E	8	52.82	8.78	6.02
F	8	53.68	9.42	5.70

HONOMU EXPERIMENT 1, 1919 CROP



FERTILIZER—AMOUNT TO APPLY TO PLANT CANE.

McBryde Experiment No. 1, 1919 Crop.*

SUMMARY.

This was an experiment to determine the profitable limit of fertilization of D 1135 plant cane, on land which has been under cultivation for about 30 years.

Nitrogen only was applied as an 18% mixture, 12% as sulphate of ammonia and 6% as nitrate of soda. The fertilizer was applied in three equal doses in November, 1917; February and May, 1918.

The harvesting results are given in the following table:

Plots	No. of Plots	Lbs. Fert. per Acre	Lbs. Nit. per Acre	Yield per Acre			Gain on E Plots	
				Cane	Q. R.	Sugar	Cane	Sugar
E	8	416.7	75	51.46	7.37	6.98	0	0
F	9	833.4	150	61.98	7.58	8.17	10.52	1.19
G	7	1250.1	225	68.88	7.87	8.75	17.42	1.77
H	8	1666.8	300	69.34	7.96	8.71	17.88	1.73

In this case applications up to 225 lbs. of nitrogen produce very decided gains. 175 lbs. nitrogen increases the yield over 75 lbs. nitrogen by 1.19 tons sugar, and 225 lbs. nitrogen increases it 1.77 tons of sugar. On the other hand, 300 lbs. of nitrogen gives a slightly poorer yield of sugar due to the poorer quality of the juices.

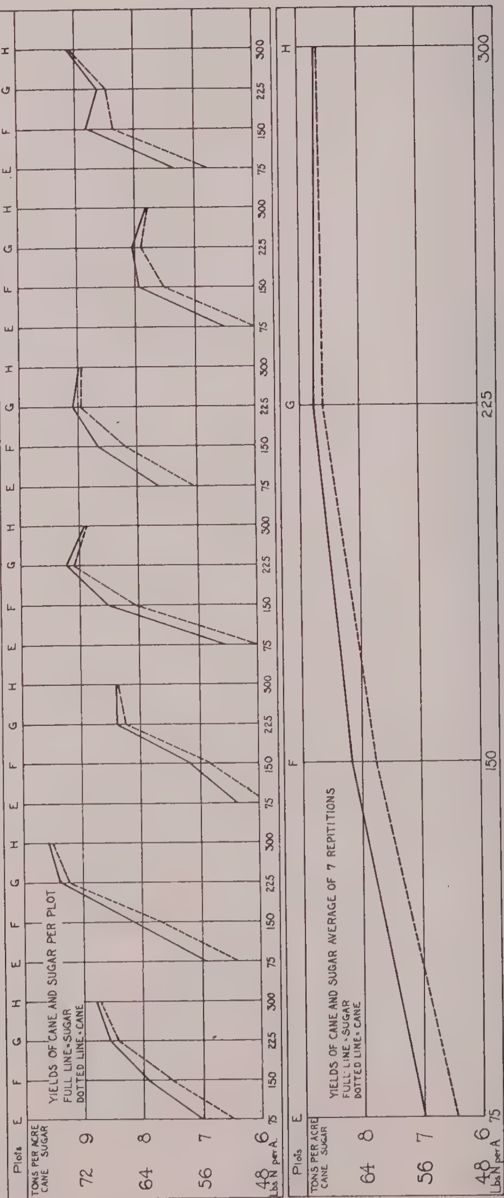
These increased yields in terms of dollars and cents give the following results:

Assuming $7.50 per ton of sugar for manufacturing, $1.50 per ton of cane for harvesting and transportation, and $25 a ton of sugar for marketing and differential, and using nitrogen at $10 a unit (nitrate of soda at $155 a ton), the following gains per acre are secured when increasing the nitrogen from 75 to 225 pounds per acre:

* Experiment planned by R. S. Thurston and L. D. Larsen.
" fertilized and harvested by R. S. Thurston.

McBryde Experiment No. 1, 1919 Crop

AMOUNT OF FERTILIZER TO APPLY TO PLANT CANE



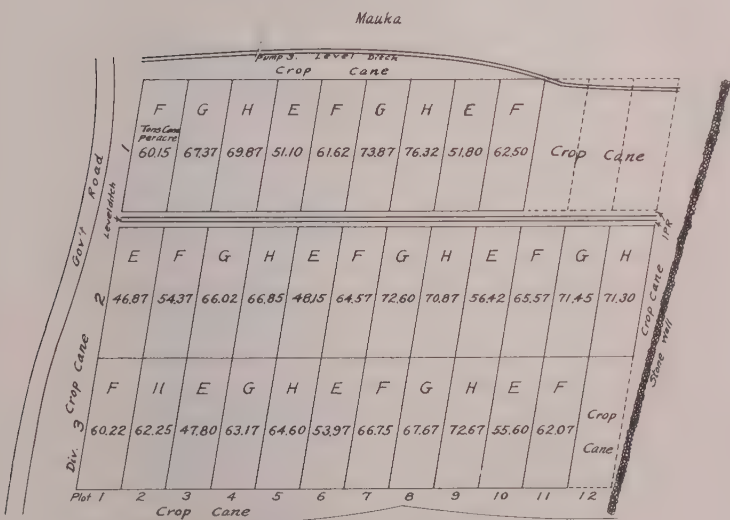
150 pounds nitrogen	$ 75.00
Harvest and transportation, 17.42 tons cane	26.13
Manufacturing 1.77 tons sugar	13.27
Marketing, etc.	44.25
Total	$158.65
1.77 tons sugar at $120	212.40
Gain per acre due to increased fertilizer	$ 53.75

Using the same cost figures, increasing the nitrogen from 150 to 225 pounds, gives a gain of $2.90 per acre.

With nitrogen at $7 a unit (nitrate of soda at $110 per ton), the gains become $76.25 and $14.15 respectively.

Amount Of Fertilizer To Apply

McBryd Sugar Co. Exp. #1, 1919 crop

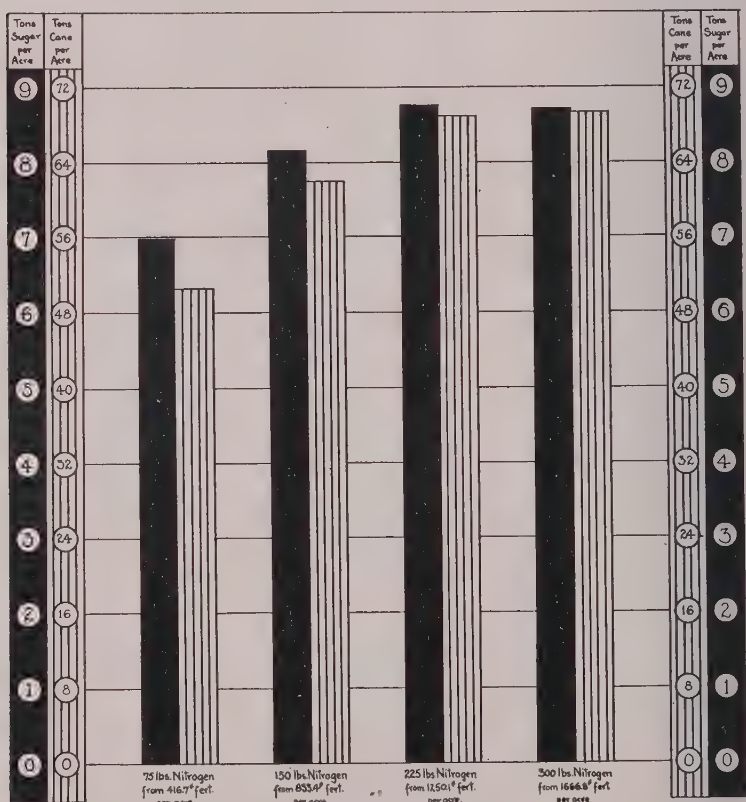


Summary of Results

Plots	Pounds of Nitrogen	Yield per acre			Gain over E plots	
		Cane	Q.R.	Sugar	Cane	Sugar
E	75	51.46	7.37	6.98	0	0
F	150	61.98	7.58	8.17	10.52	1.19
G	225	68.88	7.87	8.75	17.42	1.77
H	300	69.34	7.96	8.71	17.88	1.73

McBryde Experiment No. 1, 1919 Crop

AMOUNT OF FERTILIZER TO APPLY TO PLANT CANE



NOTE: Fertilizer 18% N., 12% from Am. Sul. and 6% from Nit. of Soda.

DETAILS OF EXPERIMENT.

Object.

To determine the most profitable amount of fertilizer to apply to D 1135 at McBryde.

Location.

Field 3 C.

Crop.

D 1135 plant cane on land that has been under cultivation for about 30 years.

Layout.

Number of plots: 32.
Size of plots: 1/10 acre, consisting of 26 straight lines.

Plan.

FERTILIZATION IN LBS. NITROGEN PER ACRE.

Plots	No. of Plots	Nov. 1, 1917	Feb. 1, 1918	May 1, 1918	Total Lbs. Nitrogen
E	8	25	25	25	75
F	9	50	50	50	150
G	7	75	75	75	225
H	8	100	100	100	300

Cane planted August, 1917; harvested February, 1919.

R. S. T.

FERTILIZER—PLANT REQUIREMENTS.

McBryde Experiment No. 2, 1919 Crop.*

SUMMARY.

This experiment is planned to determine which one or ones of the three plant foods, nitrogen, potash, or phosphoric acid, is lacking in this soil.

All plots received a uniform fertilization of nitrogen in three doses from an 18% nitrogen mixture, 12% sulphate of am-

* Experiment planned by R. S. Thurston and L. D. Larsen.
" laid out, fertilized and harvested by R. S. Thurston.

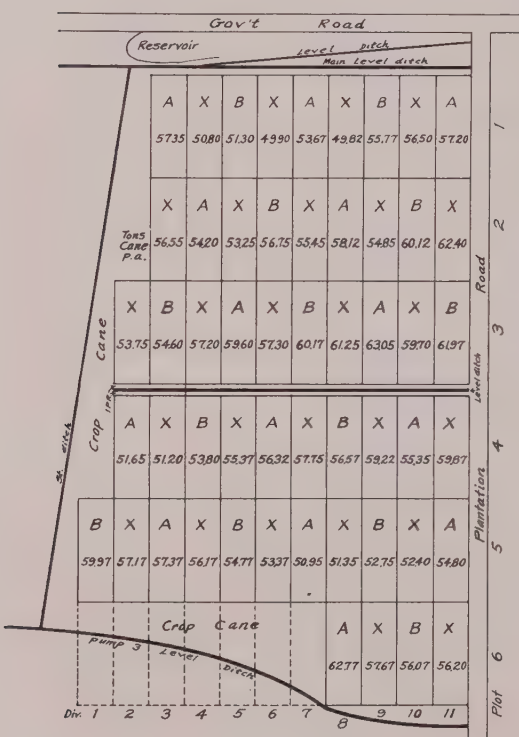
monia, and 6% nitrate of soda. In addition to nitrogen, the "A" and "B" plots received 75 pounds of phosphoric acid in the form of reverted phosphate, while the "A" plots received, in addition to the nitrogen and phosphoric acid, 75 pounds of potash from molasses ash. The phosphoric acid and potash were applied in one dose in November, 1917.

The yields of this experiment when compared with those of McBryde Experiment No. 1 show that nitrogen is the one and only plant food which it is now profitable to apply to this soil. The point of interest will be to see for how many crops this holds true. The harvesting results are as follows:

PLANT FOOD REQUIREMENTS.

McBryde Sugar Co. Exp. #2, 1919 crop

Mauka



Summary of Results

Plots	Treatment	Yield per acre: Cane	Yield per acre: Q.R.	Yield per acre: Sugar
A	Nitrogen, Phos. acid & Potash	56.60	7.53	7.52
B	Nitrogen, Phos. acid	56.51	7.44	7.60
X	Nitrogen only	55.63	7.42	7.50

Plots	No. of Plots	Treatment	Yield per Acre		
			Cane	Q. R.	Sugar
A	15	Nitrogen, phos. acid and potash...	56.60	7.53	7.52
B	13	Nitrogen and phosphoric acid.....	56.51	7.44	7.60
X	26	Nitrogen only	55.63	7.42	7.50

DETAILS OF EXPERIMENT.

Object.

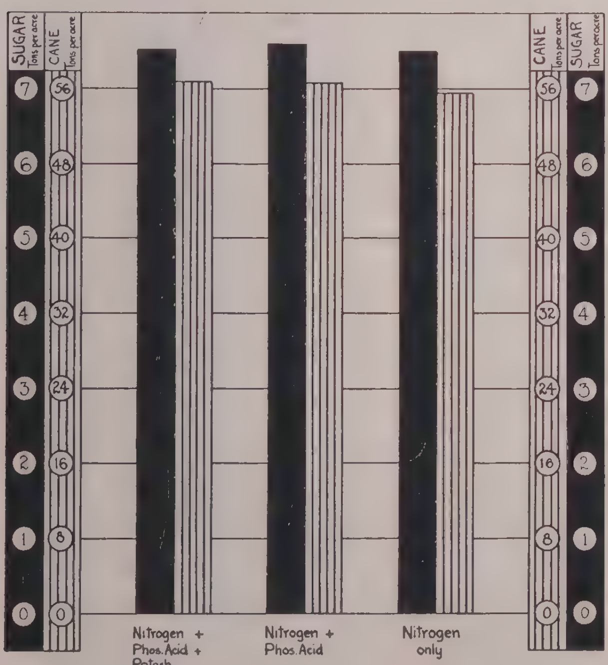
To compare the fertilizer value of nitrogen, phosphoric acid and potash.

Location.

Field 3 C.

McBryde Exp. No. 2, 1919 Crop

PLANT FOOD REQUIREMENTS



Crop.

D 1135 plant cane on land that has been under cultivation about 30 years.

Layout.

Number of plots: 53.

Size of plots: 1/10 acre (37¼′x 117′), consisting of 26 straight lines 4½′x 37¼′.

Plan.

FERTILIZATION IN POUNDS FERTILIZER PER ACRE PER APPLICATION.

Plots	No. of Plots	November, 1917			Feb., '18, N. Mixt.	May, '18, N. Mixt.
		N. Mixt.	Rev. Phos.	Ashes		
X	26	277.7	537	178	277.7	416
A	14	277.7	537	0	277.7	416
B	13	277.7	0	0	277.7	416

Reverted phosphate: 14% Cit. Sol. P_2O_5.
Ashes: 42% K_2O.
N. Mixture: 18% N., 12% sulf. ammonia, 6% nitrate of soda.

R. S. T.

NEMATODE GALLS ON SUGAR CANE.

This is a picture of the root system of a stool of H 109 cane which has evidently been severely checked by nematodes. The nematode galls may be noted as the bulb-like formations on the ends of nearly all the roots which were not broken off in lifting the cane from the soil.

MEASURES TAKEN IN JAVA TO PREVENT DETERIORATION OF STORED SUGAR.*

By H. C. Prinsen Geerligs, Ph.D.

In the present days of interrupted traffic, the preservation of staple products during the long period in which they have to be stored causes more trouble than has ever been experienced. This is the case, to a large degree, with sugar, which is packed in gunny bags and consequently is exposed to the humidity of the atmosphere.

Every investigator has come to the conclusion that the real cause of the deterioration of stored sugar is the action of microorganisms, and also that these bacteria can only perform their destructive work under certain conditions of humidity and temperature. Therefore, the proposed measures to combat deterioration are two-fold, viz., they aim at the prevention of contamination with the micro-organisms as far as possible, and next they endeavor to render the conditions of life for the organisms as unhealthy as possible.

As it is not feasible to manufacture so bulky an article as sugar by aseptic methods, the prevention of infection will only offer slight chance of success, and although the manufacturers may do all that is in their power to work as cleanly as possible, they will have to take into consideration the presence of microorganisms in their product, and will do well to keep the stored sugar under such circumstances that the action of these organisms is restricted as far as possible.

The Director of the chemical section of the Java Sugar Experiment Station, Mr. Langguth Steuerwald, publishes in the Archief voor de Java Suiker Industrie[1] his observations about the keeping qualities of the sugar from the 1917 Java crop, which was held over during the rainy season of 1917-18. Last December (1917) this quantity amounted to 1,100,000 tons, scattered over a great number of storehouses in various spots on the island. These were of very different construction, and so offered a vast field for a comparative examination into the conditions under which sugar keeps its quality in a hot climate during the rainy season, and the conditions under which it deteriorates. The first phenomena of deterioration of that sugar were already observed as early as August, but they remained insignificant and it may

* International Sugar Journal, February, 1919.
[1] Archief voor Suiker Industrie in Nederland—Indie, 1918, 879.

be said that all well-prepared sugar kept till December, a fact which had already been observed too in normal years. The only cases in which sugar lost in quality during that period were connected with an injudicious handling of the product, or with inferior construction or material of the go-downs, and might have been prevented without much trouble. But during the continuation of the rainy season in December and in January the influences of the climate made themselves felt also on the well-manufactured and well-stored sugar. At that time all differences in the quality of the sugar vanished under the influence of the climate, and the whole situation was dominated by the greater or lesser aptitude of the go-downs to preserve the sugar stored therein against the weather.

The most rapid change in the condition of the sugar was observed in stores covered with tile roofs, not only because of the tiles absorbing water at every shower and partly evaporating this into the air in the go-downs, but also owing to their low capacity of heat-transmission, which prevented the warmth of the sun from penetrating into the interior. These two circumstances co-operated to keep high the relative humidity in the storehouses, which, in many cases, did not fall below 90 per cent during the day and approached the saturation point at night-time. Since white plantation sugar absorbs moisture from the atmosphere at a relative humidity of 83.7 per cent., channel assortment at one of 75 per cent., and 96° refining crystals at one of 70 per cent., the conditions were most propitious for a copious absorption of moisture by the sugar, which thus offered a good opportunity to the ubiquitous micro-organisms to start their work of destruction.

Much trouble was taken in some places to prevent the passage of water through the tiled roof, by coating its under-side with thatching or mats, or even papering these with Chinese paper or coating them with tar, but all this could not lead to complete success, as the real reason of the high humidity was not removed. Much better results ensued by replacing a number of the tiles by glass, and by making windows in the roof, provided with glass panes, which enabled the sun to warm the atmosphere of the go-down to some extent. This, in combination with ventilation in the early morning hours when the rain was not pouring down, remedied somewhat the defects of the tiled roofs, but they were not efficient, especially in the full rainy season, when the degree of humidity of the outer atmosphere is for several days at a stretch higher than the critical limit for the sugar. The sugar cannot dry up, and ventilation can, in the most favorable case, only retard deterioration but not prevent it.

Corrugated iron roofings were much better than tiles. The

temperature in the go-downs covered by them was higher and the piles of bags looked drier. In the tile-covered rooms, the uppermost layer of bags was in many cases quite moist, while in the iron-covered ones the higher layers of the piled bags were in every instance entirely dry. Only where openings were left between the walls and the roof was the situation not so favorable, as a consequence of the night-air, which, laden with moisture, could freely enter and reach the sugar. Although the sugar kept better in such warehouses, the latter were not always irreproachable, as the surface water from the soil rose by capillarity through the earth, the sand, and the brick walls, and finally reached the sugar bags.

At every place where the bricks were laid in ordinary mortar, and that was the case in the old houses, the walls were moist, unless they had been coated with cement or with tar. The influence of the moist walls told very soon on the bags adjoining the wall, which became moist and sticky and from which a syrupy liquid oozed out.

Where also the floors allowed moisture to pass, and that was the case with earthen or tile floors, the deterioration spread also over the two or three undermost layers of bags. This may, it is true, be remedied by protecting these layers from any attraction of moisture from the soil by a layer of railway sleepers closely set together or by thatching, or by piling up the bags close together, and thereby leaving as little space as possible for attraction of moisture; but of all defects in the construction of the go-downs, the moist floors are the most serious, as they occasion relatively the greatest damage. In the most favorable case only the bottom layer becomes moist, as a rule corresponding with 5 per cent. of the stored sugar, but in other cases 10 or even 25 per cent. of the sugar decreases in value as a consequence.

The sand floors met with in most of the go-downs showed a very varying quality. Their thickness varied from 10 in. to 3 ft. Sometimes the sand was moist at a depth of only four inches below the surface, but in most cases it was dry to a considerable depth. It appears to be rather difficult to supply so much dry sand as is necessary for the filling up to a convenient depth of the floors of the very greatly extended sugar warehouses, and yet this is very necessary, because without it the usefulness of a sand floor is more imaginary than real, and the same unfavorable phenomena may be expected with earthen or tiled floors. The upper layer of moist sand will at any rate dry up gradually after the building of the warehouse, but the moisture rises up into the house and makes conditions worse for the keeping of the sugar stored therein.

However, even if the sand has been applied quite dry, it may become moist again, when in the rainy season the level of the subsoil water rises and the capillarity of the sand draws the moisture up to the surface, and allows the vapor to diffuse in the atmosphere of the go-down. The higher or lower rate of capillarity of the sand to be used is, therefore, most important for the keeping of the sugar, and it is indispensable to test that first, before using the dry sand to coat the floor.

As might be expected, the best results were obtained from impermeable floors, such as asphalt and concrete. Moreover, when using dry railway sleepers or dry thatching as a protective layer between the floor and the bags, even the undermost bags in the center of the pile remained perfectly dry on such flooring. When using asphalt floors it was even possible to pile up the bags without using sleepers, only resting them upon a layer of dry reed mats, and the same plan must be feasible too on concrete and cement floors, provided they are of good quality.

Asphalt floors may be used immediately after the layer of coating has cooled down, but concrete floors require a considerable time before they have thrown off their surplus moisture, and therefore it is indispensable to allow them to dry for a few months before using the warehouse. If for practical reasons this is impossible, a good layer of sleepers covered with thatchwork of bamboo or rattan should be put on the floor. On the top of this a thick layer of asphalted mats should be spread, and finally a layer of bamboo thatch or clean mats. In this way circulation of the air is possible underneath the bags, and when the precaution is taken to ventilate thoroughly the go-down from time to time, the ascending water vapor from the floor may be removed without reaching the sugar in the bags. As regards the walls, the same thing may be observed when they are freshly plastered. Here, too, a remedy is found in repeatedly tarring such freshly plastered or moist old surfaces, and repeating the operation till the coating of tar is glossy. Plastered bamboo thatching is not to be recommended, because even the most careful execution of the work will not prevent small openings remaining, through which communication with the outer atmosphere is maintained.

Walls of corrugated iron have been successful, except in some cases in which the sheets did not come quite close together, and the sugar consequently came in direct contact with the outer atmosphere. The great advantage of galvanized iron is its great heat-conductivity, which causes the temperature in the go-down to rise very rapidly when exposed to the rays of the sun. The corresponding disadvantage of a rapid cooling during night time

is not so serious, as the water then condensed evaporates again the next day before it has had the opportunity to render the sugar susceptible to attacks of micro-organisms.

Where all experiments and deductions led to the conclusion that a high temperature in the go-down was a favorable condition for the keeping of the sugar stored therein, it is evident that trials were called for to investigate the effect of artificially heating the warehouses combined with ventilation. But it is clear that any simple heating would be inadequate, as its only result would be a greater evaporation of water from the floor, the walls, or the roof, and consequently a higher amount of moisture in the atmosphere, which at the elevated temperature would be still more noxious than when nothing at all was done. The best method is to conduct a stream of relatively cool and dry air past a heated surface, and to fix an exhaust chimney on the opposite side of the shed, so that the draught causes the hot and dry air to pass through the whole length of the go-down, and escape up the chimney loaded with the aqueous vapor emanating from the sugar or from the floor or the walls. Dr. C. A. Browne, of New York, recommended the artificial cooling of the warehouses below the danger point of attacks by micro-organisms, while in Java heat is applied to keep the sugar dry, and thereby to prevent the action of these agents.

Langguth Steuerwald reports as follows on the condition of the part of the Java sugar crop which has remained in the island during the rainy season of 1917-18:—A large portion of that crop was sold and carried off during the months of January and February. During shipment it was possible to note what effect the moist atmosphere had exercised on the sugar, and what damage it had done. He did not dispose of the complete data, but was able to state that in most cases the damage had been practically nil. In some cases the number of bags which had become moist fluctuated between 5 and 20 per cent., while in other instances a percentage of 40 per cent. stained bags was met with. The real damage, however, was after all not so bad, since many of the stained bags were only superficially moist, and the sugar could be rendered saleable by simple rebagging. Moist sugar fetched a good price when sold locally in small parcels, while rather big quantities have been melted over in the juice of the 1918 grinding season. Sugar which had kept dry till March remained in that condition till afterwards, when the dry season set in, and even moist sugar dried up rather nicely then.

The general result of the experiments suggested that, first of all, great cleanliness and good care are necessary in order to make a sound product, containing the least possible amount of

germs. Further, the construction and the materials of the go-downs are the second great factor, influencing the keeping quality of the sugar stored during the rainy monsoon. Disinfection of the bags has proved impossible, while the treatment of stored sugar in the go-down with formaldehyde vapors was without any result. Although this disinfectant renders good services in hospitals, it proved impracticable in disinfecting so sticky and syrupy an article as sugar, which does not allow the vapors to penetrate into the interior of the bags. Drying the atmosphere in the warehouses with unslaked lime was unsuccessful, as in moist houses the lime attracted moisture so rapidly that huge amounts had to be used every day, and in spite of all the humidity did not sink appreciably.

The sugar of the 1917 crop has fortunately been shipped; and the 1918 crop is being sold more rapidly than was once anticipated. In 1919 the production will be greatly restricted and, if circumstances remain as bad as they are now, there is every prospect of the 1920 crop being a very small one too. The necessity for storing abnormal amounts of sugar in the rainy season has therefore lost much of its significance for Java, but the experience gathered in the year 1917-18 may be useful for other times or other places. [W. R. M.]

THE SUGAR INDUSTRY IN MEXICO.*

It is barely 30 years since the sugar production of Mexico entered on its modern phase and became an appreciable industry. Till that time the Revolutions, which following on the war of independence succeeded one another unceasingly and led to a chaotic state of affairs in the country generally, precluded any organization on a large scale of an industry demanding considerable capital to work it, plenty of labor, and means of rapid communication for the transport to a considerable distance of an easily damaged foodstuff, and of a production which exceeded the needs of the local consumption. The system of cultivation and industry hence retained, without any appreciable change down to the last 20 years of the nineteenth century, the character and methods of the old colonial days, modified at most in some haciendas by the introduction of a less primitive procedure and

* Translated from the Bulletin de la Chambre de Commerce Francaise du Mexique in The International Sugar Journal, Vol. XXI, February, 1919.

of a more scientific agricultural technique. And, whereas in the other countries of America such as Cuba and Argentina, the manufacture of sugar tended to get centered in several huge factories, in Mexico the production remained distributed amongst more than 3000 planters and small farmers who were content to produce for a clientele confined to the most adjacent markets and who limited their manufacture almost exclusively to turning out *panela* and *piloncillo* sugars, with which the great bulk of the Mexican people was still content; only the rich classes consumed white sugar imported from Europe or the United States.

But towards the year 1880 this primitive industry, which elsewhere in America had shown a considerable advance, was not long in showing some improvement under the beneficent influence of the economic progress which followed the rise to power of General Porfirio Diaz. The spirit of enterprise began to develop amongst the principal planters with increasing energy, especially in the State of Morelos.

During the decade of 1890-1900 the improvement was accentuated at several places in Mexico; large usines were set up, dowered with modern plant and apparatus, and in place of the traditional methods there were substituted, both as regards cultivation and factory operation, scientific procedures which assured a more complete extraction while at the same time permitting the manufacture of a sugar of a much superior quality. Simultaneously, the country, thenceforth freed from political strife with its barren agitation, spurred itself on in all directions towards the acquisition of material comforts which went far to increase its capacity for sugar consumption and accentuate its preference for the more refined sorts of sugar which the new usines placed on the market; so that whereas once it was almost exclusively the rich classes who demanded white refined sugar, the latter now rapidly replaced the sale of *piloncillo* even amongst the poorest classes.

The period 1900-1910 marked the zenith of this industrial effort. In the central territories where it had been domiciled since the first days of the Spanish conquest, the cultivation of the cane made headway amidst the fertile coastal regions; large usines were erected in the States of Vera Cruz, S. Luis Potosi, and Sinaloa. They were owned chiefly by foreign companies which organized and exploited the new centers, such being "La Cia. Agricola Industrial Francesa del Paraiso Novillero," the hacienda "El Potrero," "The Cuatotolapam Sugar Company," La Cia. Azucarera del Pánuco," "TheRáscon Manufacturing and Development Co.," "The Sinaloa Sugar Company," etc. This introduction of foreign capital and enterprise had the effect of

stimulating Mexican initiative. At the same time, the Government, anxious to encourage the development of an industry which revealed such energy, did not hesitate to impose on foreign sugar a prohibitive duty of five sous (2½d.) the kilogram. Protected by this tariff from all fear of foreign competition the planters continued to increase the output of their usines till a point was reached when production promised to exceed the consumption. The planters then remedied this by substituting in part or in whole, for their manufacture of white sugar, the production of *mascabado* or 96° raw sugar which had an assured and remunerative sale on the British and American markets. Starting with some hundreds of tons of this raw sugar, the exports rose rapidly to 25,000 tons in 1911.

The following tables, which in default of official figures are taken from the sugar review published by *El Haciendado Mexicano*, show the remarkable progress of the Mexican sugar production between 1898 and 1911:—

Season.	Tons.	Season.	Tons.
1898-99	50,000	1905-06	107,000
1899-00	75,000	1906-07	119,000
1900-01	95,000	1907-08	123,000
1901-02	103,000	1908-09	143,000
1902-03	112,000	1909-10	148,000
1903-04	107,000	1910-11	160,000
1904-05	107,000		

The crop of the last campaign mentioned above, that of 1910-11, was distributed as follows among the producing States:—

State.	Metric Tons.	State.	Metric Tons.
Morelos	49,747	Tepic	3,500
Veracruz	40,868	Oaxaca	3,217
Puebla	20,364	Tabasco	2,945
Sinaloa	12,255	Guerrero	2,812
Michoacan	10,350	Tamaulipas	2,810
Jalisco	4,850	Colima	1,550
San Luis Potosi	4,768	Other States	1,565

It is difficult to estimate exactly the extent of the consumption in the absence of all official figures. We know, however, that under the influence of the well-being which has by successive stages spread to all sections of the community, the consumption of sugar has increased in notable proportion, and if we consider that in 1911 the production was 160,000 tons, the exports 25,000 tons, and that 30,000 to 35,000 tons were retained by the trade to build up a reserve, we may suppose that the difference, that is 100,000 to 105,000 tons, represents the indigenous consumption in the year in question. For a population of some 16 million inhabitants it works out at about 6 kg. (13.2 lbs.) per head. This figure coincides very nearly with that of other countries of

America, Peru for example, so that we can consider it as approximately correct.

The 1910-11 campaigns in Mexico marked the zenith of an industry which, with the further developments that were possible, promised to be established as a leading element in the wealth of the country. There is no doubt that the enormous area of fertile territory which the coastal regions offer for the cultivation of the cane would in the near future have placed Mexico in the front row of the large producing countries.

It was, however, at this moment of great prosperity and brilliant hopes that the Madériste revolution occurred and started the long civil war which has not ceased since to unsettle the country. For the ascending curve of production there has been substituted since 1912 a descending one which registered the following quantities of output:—

Year.	Tons.	Year.	Tons.
1911-12	152,000	1915-16	65,000
1912-13	148,000	1916-17	50,000
1913-14	130,000	1917-18	35,000
1914-15	?		

The last figure of 35,000 tons appears on the basis of the campaign results to be more favorable than the preliminary estimates, having been increased by some thousands of tons.

This steady retrogression is to be attributed to the increasingly difficult conditions in which the Mexican sugar industry has been placed in the course of the last few years. The State of Morelos, which, as we have seen, once accounted for one-third of the total production, has been for six years in the hands of the Zapatistes, and has not been able to deliver a single kg. of sugar to the consumption. It is to be presumed that all its fine usines have arrived at a state bordering on ruin. The Zapatistes are almost certain to have deprived them of all material that was of use for war purposes, and to have dismantled the rest. The industry in the State of Puebla is very nearly if not quite in the same deplorable condition. The damage is less in Veracruz; the numerous armed bands in the course of frequent visits to the usines usually contented themselves with plundering the safes and provision stores, or with levying from their proprietors a contribution to the war; they at least respected the buildings and plant. But if, then, manufacture has not in this State been entirely suspended, it has at all events been sensibly diminished. In S. Luis Potosi the Hacienda de Rascón, the most important one in the district, so often received visits from rebel troops that the proprietors were forced to resort to closing down definitely and disbanding their employees. The other chief

States, such as Michoacan, Jalisco, Tepic, Oaxaca, have not fared better. The sugar industry of Sinaloa alone appears to have escaped all damage, as so far this region has remained outside the zone of action of the rebel factions. Its prosperity appears to be greater than ever, if one is to believe the news published in the newspapers in the capital; according to these, the last campaign yielded an output of more than 20,000 tons, which compares with 12,250 tons in 1911-12, 11,500 tons in 1912-13, and 16,000 tons in 1913-14.

This brilliant exception can unfortunately not alleviate the general evil save in infinitesimal degree. The last few crops have been greatly deficient, and towards the end of last year the market position was at one moment most critical owing to the exhaustion of available stocks. An acute crisis would have developed but for the timely arrival of some thousands of tons of sugar from Central America. Then last March the 15,000 tons of sugar which the Cuban Government agreed to allow Mexico, and the placing on the market of the first sugar of the last campaign succeeded in easening the situation. During those difficult days the prices rose to a level never hitherto attained. In December the retail price of granulated and cubes rose one day to $1 for the former and $1.15 for the latter. But bit by bit, under the influence of fresh arrivals, prices were not long in descending once more to present figures, at which they seem inclined to be stabilized, of 60c for white granulated and 75c for cubes. Yet, in other words, in Mexico, a producing country, a neighbor of large centers of production such as Cuba and Central America, and which levies no import duty on foreign sugar, this foodstuff costs very much more than in Allied countries where sugar is saddled with considerable taxation, and burdened with very heavy costs in freight and insurance. It is true, on the other hand, that in Mexico they do not know what it is to be rationed; that is an advantage appreciated by those whose resources have not been diminished by the general depression; but these are unfortunately in the minority.

This situation, which affects so harshly producers and consumers alike, is it at least susceptible of improvement in the near future? One fears not. It is possible that the present-day high prices may tend to stimulate certain fresh ventures and that, for example, the planters who have been able to work this year under conditions just tolerable may extend further their cane plantings. We might count in this case on an increase of several thousand tons, an expansion nevertheless insufficient to place the production on a level with the consumption, so resource will have to be had to foreign sugar to make up the deficiency. As

for the plantations and usines destroyed in Morelos and elsewhere, it is doubtful whether their proprietors will consent to incur the necessary expense to restore them, so long as they are without any guarantee against the return of new disasters; their confidence will only be restored by the occurrence of a number of years of uninterrupted peace.

THE ELECTRIFICATION OF SEEDS.*

This process has now reached a stage of practical success that requires some notice in Science Progress. Begun with experiments in a few pots, it has advanced year by year to larger and larger plots of ground, until at the present time electrified seed is being grown on more than 2000 acres. These 2000 acres are now ripe for harvest, and in many cases are being harvested, so that a decisive judgment on the merits of the process can now be formed, and it may be said at once that the judgment of competent experts who have visited the farms and examined the crops is all one way, and is extremely favorable. These experts include representatives of several foreign Governments, of our own Government, of important newspapers, as well as men who are distinguished in the world of agriculture, and whose names are widely known as experts on this subject.

The various government representatives will, of course, report to their respective governments, and it would not be becoming of me to forestall their reports, though in several cases the general trend, and even the specific recommendations, have been communicated to me without any injunction as to secrecy; but I am violating no confidence when I say that, so far as they are known to me—and only one gentleman carried official reticence to the point of giving no indication either way—they are uniformly favorable, and for the most even enthusiastic.

The difference between the crops grown from the treated and those grown from the untreated seed are manifold, and it is important to remember that in every case the treated and the untreated seed were taken from the same bulk, were sown on the same land, in the same field, at the same time, were subjected to the same cultivation, were examined at the same time, and, those that were reaped, reaped on the same day. It is im-

* By Charles Mercier, M. D., F. R. C. P., in Science Progress, Vol. XIII, No. 51, January, 1919.

portant also to bear in mind that in all the cases to which reference is made here the crops were grown by practical agriculturists under ordinary farming conditions, for their own satisfaction, and with a view to the adoption or rejection of the electrified seed in future years. Such tests have not the rigorous scientific exactitude of tests made by scientific experts at experimental stations, but they are not less trustworthy as guides to the practical farmer. Experiments in the scientific manner have been carried out at five or six experimental stations, but the reports are not yet to hand, and therefore cannot be given here.

A practical agriculturist who has spent his life in farming can estimate within a small margin of error, by mere inspection of a growing crop of grain immediately before harvest, how many bushels per acre the crop will yield. The estimate seems to the non-expert a risky one, and one likely to be falsified by the threshing machine; but in practice it is not found to be so. The *flair* of the farmer in scenting the yield of his crop is analogous to the *tactus eruditus* of the physician, to the judgment of the cloth merchant as to the wearing quality of a cloth, to that of a wine merchant as to the value of a fine wine, or that of a tea-taster as to the proper blend of varieties of leaf. These things are not to be measured or expressed in accurate figures. They are personal judgments, made possible by long experience and attention based upon native capacity. Yet great trades are built up upon them, and serious errors are almost unknown. Such is the skill of the expert farmer in gauging the yield of his crops. The government has such reliance on his skill that it publishes every year the probable yield of the harvest before ever a field has been reaped, and the estimate is never much astray.

The first and most important differences between the crops grown from electrified seed and those grown from unelectrified is the increase in the yield of the former. Estimated in the way above described, half a dozen have shown a difference of from eight to twelve bushels per acre. In the case of wheat, this means a difference of from 25 to 37 per cent. Estimates made of other crops by experts inspecting singly have been in some cases less, in other cases more than this, but probably, as far as can be judged from the reports that are as yet to hand, the figures mentioned represent about the average.

The second difference is that the crops from electrified seed show a greater weight per bushel, ranging from one to four pounds. This is very important, as every one who keeps horses knows. It means the difference between a poor sample and a mediocre sample. It means the difference between a mediocre sample and a first-rate sample. It means the difference between

a sample that can be used only for milling and a sample that can be used for seed. It means better milling quality, more flour, and less offal.

The third difference is in the length of the straw. This is susceptible of actual measurement, and it is found by measurement that the straw growing from the electrified seed is from two to as much as eight inches longer than that growing from the untreated seed.

The fourth difference is in the stoutness and the strength of the straw. 75 culms of unelectrified oat straw tied up in a bundle measured 3¾ in. in circumference. The same number of culms from electrified seed measured 4¾ in.—an excess of 26⅔ per cent.

From this follows the fifth difference, that the crop from electrified seed stands better than that from unelectrified seed. After the thunderstorms at the end of July, in field after field the electrified crop was standing upright, while the adjacent unelectrified seed was, in large patches, flat upon the ground.

The sixth difference is that the electrified seed tillers much more than the unelectrified—that is to say, it throws up many more culms, and therefore each plant occupies more ground and produces more ears in the case of wheat and barley, more panicles in the case of oats. Consequently, the same quantity of seed produces a heavier crop, or a smaller quantity of seed may be used to produce the same amount of crop. In one case—on the farm of Mr. Legg, near Corfe Castle—5 acres were sown with electrified oats at 3½ bushels per acre, and 5 acres adjoining were sown with oats of the same sample, but unelectrified, at 4 bushels per acre. The produce of the electrified was a much thicker plant, stouter and longer straw, more numerous and heavier ears of grain.

The results are established. They are not uniform. Every crop does not exhibit the same degree of contrast as every other, but practically every crop shows a substantial contrast—much more than enough to repay the cost of the treatment. The process is now past the experimental stage, and is become established. It would be absurd to treat it as still uncertain when such results have been shown on 2000 acres of land of the most various quality in widely different parts of the country.

The rationale of the process is unknown. Whether it acts by stimulating the energy locked up in the ungerminated seed; or by the addition by ionisation of ions that assist the growth of the seed; or by destroying certain bacteria, or the spores of certain fungi; or by stimulating the growth of other bacteria or other fungi; or in some other way, is not known. Here is a most

fertile field for investigation, for at the present time we are feeling our way in the dark. It is found, for instance, that, to obtain equivalent results, barley must be treated for twice as long as wheat. Every kind of seed needs its own special treatment, which can be determined only by a long and careful course of experimentation, extending, it may be, over several seasons. For many seeds the correct mode of treatment has not yet been discovered, and up to the present no result has been obtained; but there is every reason to suppose that results will be obtained in time. It is evident that if the rationale of the process were known, this time might be very sensibly abbreviated. Here, then, is a field of investigation waiting and clamoring to be cultivated, and certain to achieve important results.

Postscript.—Since the foregoing account was written, some of the measured results of the harvest of 1918 have come to hand. They show gains from the crops growing from electrified seed over the crops growing in the same fields from unelectrified seed of from 9 per cent to more than 60 per cent, the average being more than 30 per cent. *Verbum sapientis.*

NOTE ON THE COLLOID CHEMISTRY OF FEHLING'S SUGAR TEST.*

By Martin H. Fischer, M. D., and Marian O. Hooker, M. D.

Every chemist, when working with Fehling's sugar test, has noticed that its reduction does not always yield a bright red precipitate, but frequently one that is more orange or distinctly yellow; while under certain circumstances only a greenish discoloration of the originally bright blue solution is obtained, from which at the best a light greenish or dirty yellow precipitate may settle out in the course of many days.

Explanations of these findings are for the most part chemical in nature. The appearance of the green color with little tendency to form a precipitate is often regarded as entirely questionable evidence of the presence of dextrose or other reducing material. The yellow precipitate is usually accepted as clear proof of the presence of a reducing sugar, but this yellow substance is not considered identical chemically with the red cuprous

* Reprinted in International Sugar Journal, December, 1918, from Journal of Laboratory and Clinical Medicine.

oxide. Many, for example, hold the yellow precipitate to be a hydrated form of the copper oxide.

Because of this confusion regarding the nature of the interpretation of the reaction, we decided to examine it from a colloid chemical point of view, for we felt in advance that the explanation of what was really at the bottom of these apparent differences in end results was more likely to be found in these regions than in the more commonly studied ones of pure chemistry. We felt that Fehling's reduction test under different circumstances does not yield chemically different copper oxides, but one and the same oxide in different degrees of subdivision, or, in the language of the colloid chemist, possessed of different degrees of dispersion.

That one and the same chemical compound (as a metal, a sulphide, or an oxide) may in the colloid state show different colors has long been known to different workers[1]. It has, however, remained for Ostwald[2] to recognize that these color varieties tend on the whole to follow a general order coördinate with the size of the dispersed particles. The more highly dispersed particles of a given substance are likely to be yellow; as their size decreases they become orange, then red, and finally violet, blue, or black.

When the ordinary brilliantly blue Fehling's solution is mixed with a little reducing sugar solution, without boiling as ordinarily, but simply allowing to stand a number of hours at room temperature, a series of such color changes may be observed. The originally clear Fehling's solution easily loses its brilliancy and assumes a more opaque blue color, soon passing from this to a leaf green, and then to a yellow green. At this time more or less precipitate may separate out; later, not only this yellow precipitate, but the supernatant liquid as well becomes yellow orange, then brilliantly orange, and finally assumes the well-known bright red.

It is of interest to follow the microscopic appearances which are co-incident with these macroscopic optical changes. This may be done by examining drops of fluid from different tubes as the different colors are developed, or the whole of the series may be observed in one and the same drop as the reduction progresses under the microscope. Examined microscopically, or ultramicroscopically, the original Fehling's solution is optically homogeneous. If a drop of the fluid from a less brilliant tube is examined, one early becomes conscious of a vague blurring in

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[1] The Svedberg: "Herstellung Kolloider Lösungen," Dresden, 1909, in which volume detailed references to older observations may be found.

[2] Wolfang Ostwald: "Kolloid-chem. Beihefte," 1911, II, 409. "Theoretical and Applied Colloid-Chemistry." Translated by Fischer, 1917, New York, p. 62.

the microscopic field. By waiting a little, this is seen to be followed by a brilliant lighting-up of the field through vast numbers of actively motile particles. We may examine drops of fluid from the yellow, orange, or red tubes, or we may simply watch the original preparation under the microscope as this passes successfully through these same color changes, when it is seen that the particles gradually grow in size. These observations show, therefore, that the different colors observed in the reduction of Fehling's solution by reducing substances are nothing more than color changes coincident with a gradual increase in the size of copper oxide particles. These show, moreover, that any of the positive reactions here described (whether they yield merely a dirty green solution, a yellow or orange precipitate, or the brilliantly red precipitate so generally sought) indicate equally well the presence of a reducing substance. In other words, a dirty pea-green solution means just as much from a qualitative point of view as does a red precipitate. In the case of dextrose, for example, the presence of much of this material is quite as likely, in fact more likely, other things being equal, to yield merely a greenish discoloration or a yellow precipitate than is a lesser amount. In fact, to insure getting the red precipitate, one must in all instances use *little* enough of the reducing material. Generally speaking, amounts of dextrose too small to reduce all the copper salt present will more definitely yield a red or an orange precipitate than larger amounts. This fact will, of course, be readily intelligible to the colloid chemist. With much sugar present, the number of points at which the copper salt is attacked and reduced will evidently be much larger than when less sugar is added. All the available copper salt for the further growth of the particles will, therefore, have been exhausted when the copper oxide particles are still small, wherefore the presence of too much reducing substance is more likely to yield only the allegedly ambiguous end-reaction than when less is used.

Another factor must, however, be considered as active in determining what the end result will be. Obviously, if the reduced copper oxide can be stabilized anywhere in its progress from the finely divided material to the coarse red, then one of the intermediate colors is obtained. As is also familiar to the colloid chemist, such stabilization of a finely divided suspension colloid is commonly brought about through the presence in the reaction mixture of various hydrophilic (lyophilic) colloids. If to the solution of a reducing sugar used to produce the series of color reactions under discussion we add some mucin, acacia, gelatin, egg-white or some other hydrophilic colloid, the rate at which the various colors are obtained is much delayed. In fact, if the

concentrations are chosen properly, only dirty green or yellowish green reductions may be obtained, no matter how much copper oxide reducing substance may be present. The copper oxide may, in other words, be stabilized in any of its various states of subdivision. The scientific basis of the old trick of diluting heavily the material to be examined whenever such questionable reductions are obtained is easily seen. Dilution not only dilutes the highly concentrated reducing substance, but, more important, it dilutes the stabilizing colloids to a point where their powers in this direction are largely lost.

In addition to the concentration of the reducing substance itself, and the concentration of the various protective colloids which may be present, comes a third factor which determines the nature of the end result. When a reducing sugar is treated with an alkali, a series of degradation products is formed, as is well known, and it is these which in their turn are the elements directly responsible for the reduction of the copper salt. In the formation of these degradation products, however, some are produced which are in themselves colloid and hydrophilic in type. When, therefore, too much of a solution containing dextrose or any similar reducing substance is added to Fehling's solution, there appears the danger of getting intermediate colloid substances which in themselves tend to stabilize the copper oxide before it has attained the coarse dimensions necessary to yield an orange or red precipitate.

Regarding the effects of temperature in the production of the red precipitate, reduction at high temperature (as in the usual procedure) is more likely to yield the colloid types of reduction products than lower ones (like room temperature). A urine containing an amount of reducing body which upon boiling yields only a dirty green solution, will show a bright red precipitate if the same proportions of urine and Fehling's solution are simply mixed and set aside at room temperature for twenty-four hours. The reasons for such improvement are probably several, but the most important would seem to be the initiation of the reduction at fewer points under the latter circumstances, while, because of the greater time element, these fewer points would then be given better opportunity to grow to the sizes characteristic of the red precipitate.

Since we published this note, and another article on the same subject[1], Stanley Benedict has called our attention to the fact that many of the points made in our communication have been previously recognized by Hugh MacLean[2], who, in 1906, ques-

[1] Science, 1917, XLV, 505.
[2] British Medical Journal, 1907, I, 1471.

tioned the chemical nature of the differences in the results obtained upon reducing Fehling's solution, and brought forth evidence which he felt indicated that these differences were merely physical. Failure to get a red precipitate MacLean held to be due to something which keeps the cuprous oxide "in solution." If the word "solution" is not interpreted too strictly, but in the way in which it was used a decade ago when we still felt free to speak of liquid colloid suspensions as "solutions," then no objection must be raised to this contention of the author. As a matter of fact, in developing his theme he shows that what he means by "solution" *is* a suspension of particles of different sizes. He demonstrates these differences by showing that the green, the yellow, the orange, and the red liquids, or precipitates, pass with increasing difficulty through filters of known porosity. Finally, in trying to say what it is, in urine for example, which keeps the cuprous oxide "in solution" (or, in more modern terms, in a state of high dispersion) he fixes first attention upon the presence of creatinin, holding that this substance (rather specifically it would seem) keeps the cuprous oxide "in solution." But considering the fact that any hydrophilic colloid which is not dehydrated by the conditions of the experiment will retard or prevent the development of the cuprous oxide to its red form, a specific action is probably not to be assigned to the creatinin.

[W. R. M.]

THE AUSTRALIAN SUGAR INDUSTRY.*

By Harry T. Easterby.

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Part I.—cane sugar.

The problem of the sugar industry in Queensland, which supplies over 90 per cent of Australian-grown sugar, is so many-sided and is governed by so many factors that it forms in itself a complicated study of no mean magnitude, and one which it is impossible to deal with completely in a paper of this length. The

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industry has also during late years been closely bound up with politics, both Federal and State, and this has not conduced to clear the situation.

In this part of my paper I propose to divide the subject under several heads, each of which will be dealt with as briefly as possible. These will include—

- (*a*) Short History of the Queensland Sugar Industry prior to Federation.
- (*b*) Review of the Industry since Federation.
- (*c*) Scientific Work, Varieties of Cane, Cultivation, Soils, Pests, Milling Work.
- (*d*) Comparison with other Countries.
- (*e*) Labor and Wages.
- (*f*) Health in the Tropics.
- (*g*) Utilization of molasses.
- (*h*) Present-day Problems. Foreign Settlement.
- (*i*) National Importance of the Industry and need for Federal Protection.
- (*j*) Expansion of the Industry.

(*a*) SHORT HISTORY OF THE INDUSTRY PRIOR TO FEDERATION.

The Cane-sugar Industry in Queensland, like many others, commenced on an insignificant scale early in the history of the then Colony. This year (1917) it will produce more sugar than can be consumed in Australia.

It was stated in a Report on the Sugar Industry made in 1880 by Mr. Henry Ling Roth, to whom I am indebted for many of the following details, that as far back as 1823 Mr. Thomas Scott, under the patronage of Sir Thomas Brisbane, succeeded in growing sugar cane at Port Macquarie, in New South Wales, and manufacturing 70 tons of sugar. Mr. Scott worked hard, both practically and by ventilation of the subject in local newspapers, to prove that sugar could be manufactured in that Colony. In 1849 proposals were made for the formation of a sugar company in South Brisbane, and there is said to have been a small plantation at Eagle Farm, on the Brisbane River, but apparently no sugar was made. Sugar cane was cultivated in the gardens of several people in Brisbane about this time, and a considerable amount was also grown in the Government Botanical Gardens. The first sugar produced in Queensland, according to Mr. Walter Hill, at one time in charge of the Botanical Gardens, Brisbane, was made as follows: Sugar cane was taken from the Botanical Gardens in December, 1859, and passed between two steel rollers. The

juice was taken back to the Gardens, and about 6 lbs. of sugar was made in a copper vessel. The first sugar made in Queensland, however, of which there is any official record, was manufactured by Mr. John Buhot, in 1862. In 1863 Captain Louis Hope had 20 acres under cane on Ormiston plantation, near Brisbane, and that gentleman is generally conceded to be the father of the Queensland industry. In 1863 the London Society of Arts offered a medal for the first ton of sugar made in the Colony. The first sugar-cane plants were most probably imported from Java and Mauritius, and about this time the Queensland Acclimatization Society took active steps in bringing over a large number of varieties. A tremendous impetus was given to the industry when land was made available for some years by the Government on remarkably easy terms for sugar growing, and in 1865 as much as 18,290 acres had been taken up for cane planting. Shipments of cane were this year made to New South Wales farmers for planting.

The early stages of the industry were almost entirely devoted to the production of cane, and the extension of land under cultivation. In 1866 so great was the demand for plants that there was actually a scarcity of cane for planting.

By the end of 1867 there were nearly 2,000 acres under cane, and six mills had been erected which between them manufactured 168 tons of sugar. There was, however, an insufficiency of mills, which caused heavy losses to the farmers, but mill-owners did well, as they could buy cane for 4s. a ton.

Up to this time the industry had been carried on entirely in Southern Queensland, but it now began to spread to Bundaberg, Mackay, the Herbert and Johnstone Rivers, and Cairns. It is in these places today that almost the entire output is manufactured, the extreme southern districts making very little.

Sugar growing continued to prosper, more land was brought under cultivation, and steam mills quickly superseded the antiquated cattle and horse power erections.

In 1875 a disease termed "rust" broke out in the cane. This, combined with an excessive rainfall, fell like a thunderclap on farmers, and brought ruin to many of them. The financial institutions became alarmed, and refused to render further aid. Planters, however, were too energetic to let their estates go out of cultivation. The variety affected was known as the "Bourbon" cane, but it was noticed that small patches of "Rappoe" or "Rose Bamboo" were not touched. Those who survived the blow commenced the cultivation of this variety, and confidence was soon restored, though many plantations changed hands. During 1879 and 1880 a rush set in for Queensland sugar lands, and plenty of

capital was made available. The production of sugar in 1870 and 1880 is given as follows: 1870, 2,854 tons; 1880, 15,681 tons.

During the next decade, 1881 to 1890, the production of sugar in tons varied from 16,660 to 68,924, and from 1891 to 1900, 51,219 to 163,734. During the period under consideration a large number of small mills were erected in most of the sugar-growing areas of the State, as well as many large factories. On the decline of prices owing to the stimulation of bounty-fed sugar in Europe, most of the small mills went under. During this time, also, a number of modern mills were erected under the Sugar Works Guarantee Acts, with capital found by the Queensland Government. These were known as "central mills," and led to a further reduction in the small privately-owned mills. In 1901 there were some 60 sugar-mills in existence in Queensland.

From 1863 to the advent of Federation in 1901, the Sugar Industry was almost entirely carried on by labor from the South Sea Islands. This class of labor, while eminently serviceable and of great use in opening up the country, was always distasteful to the majority of Australians, and when Federation took place steps were taken to make the industry entirely a "white" one. This was accomplished by passing a measure prohibiting kanakas entering Australia after 1904, and providing for the deportation of those who had already been engaged within a certain period. This only left some 2,000 kanakas in Queensland, the majority of whom had resided for years in the State and had married. About the same time the Federal Excise Act came into operation, which provided for an import duty of £6 per ton on all foreign sugar. An Excise duty was collected on sugar manufactured in Australia, and a rebate was given to that in which white labor was used.

(*b*). REVIEW OF THE INDUSTRY SINCE FEDERATION.

Since the establishment of the Commonwealth a great change has taken place in the Queensland Sugar Industry. Recognizing the trend of events, the large planters (who were in many cases millers), and who had not previously cut up their lands, did so now, which led to the settlement of a further number of small farmers as cane growers. This had been accomplished to some extent already by the State Government's encouragement of the building of central mills. The colored labor previously employed in the industry has been almost wholly replaced by the white races. The sixteen years that have elapsed since Federation have seen a further decrease of the small uneconomic mill and a general increase in the efficiency and management of the larger surviving mills. This has been followed by the growing of better

varieties of cane by the farmer, and a general improvement in the tonnage of cane and sugar per acre grown by improved methods of cultivation. At the end of 1916 the number of sugar mills was 45. This included three new large and thoroughly up-to-date mills erected since 1913, viz., Inkerman, Babinda, and South Johnstone. The first of these is in the Lower Burdekin district, south of Townsville, and is the property of Messrs. Drysdale Bros. The Babinda and South Johnstone mills have been erected by the Queensland Government to develop the rich tropical lands south of Cairns. These two mills, which are the latest word in sugar-crushing plants, cost in all £754,000.

The output of sugar has steadily increased in normal years. Drought years, of course, reduce the average output. The yield of sugar produced yearly in Queensland since 1901 is as follows:

Year.	Tons Sugar.	Year.	Tons Sugar.
1901	120,858	1910	210,756
1902	76,626	1911	173,296
1903	91,828	1912	113,060
1904	147,688	1913	242,837
1905	152,722	1914	225,847
1906	184,377	1915	140,496
1907	188,307	1916	176,973
1908	151,098	1917	340,000
1909	134,584		(approximate)

Queensland now produces above 91 per cent of the total yield of sugar in Australia.

Since Federation to 1915 the average shortage between the production of sugar by Queensland and New South Wales may be set down at 45,000 tons. This has been due first to the uncertainty that prevailed at the time of the transition period, during which white was being substituted for colored labor, secondly to climatic drawbacks, and thirdly to the fact that all the mills in Southern Queensland have not during the past ten years been supplied to more than 52 per cent of their full capacity, while more cane could also be grown for some of the northern mills if the future of the industry were assured.

Of the 45 mills above referred to, 6 were owned by the Colonial Sugar Refining Company, 15 were Central Mills, erected by the Government, and the remainder were mills owned by private persons or companies; included in the latter class being all the remaining small mills, *i. e.*, those whose capacity was 15,000 tons of cane and under.

The amount of capital invested in factories and farms is now stated to be some £9,000,000.

(*c*). SCIENTIFIC WORK, VARIETIES OF CANE, SOILS, CULTIVATION, PESTS, MILLING WORK.

The Government of Queensland (which has naturally always taken a warm interest in the sugar industry) in 1900 established a Bureau of Sugar Experiment Stations. This institution has at present two Experiment Stations, one at Mackay and the other at Bundaberg, while a third is about to be established in the Johnstone River sugar district, near Innisfail. Laboratories are established at which soil investigations are undertaken, and analyses of fertilizers, limestones, waters, sugar canes, and sugar-mill products are carried out for growers and millers. The introduction of new varieties of cane from other countries is a part of the Bureau's work, and their testing upon commercial lines both in the field and laboratory entails a great deal of patient investigation. In addition to this, experiments in cultivation, rotation, fertilizing, and irrigation have been and are still being carried on, and the results are published yearly in the Annual Report of the Bureau.

A large number of the varieties of cane introduced in recent years were brought from the adjacent island of Papua. Many of these are stated to be growing in the gardens of the natives, where they are used for eating purposes at their festivals.

The best variety of cane brought into Queensland so far is a New Guinea cane with the name of Badila. This was introduced by the Department of Agriculture through one of its officers (Mr. H. Tryon, Entomologist), who in 1895 visited Papua and secured some 66 varieties. It is an exceedingly rich cane, with a small percentage of fibre. The following is an analysis:

Brix, Total Solids	Per Cent Sucrose in Juice.	Per cent Glucose in Juice.	Per cent Sucrose in Cane.	Quotient of Purity.	Available Sugar.
22.6	21.4	0.21	18.6	95.0	17.85

Queensland has always been well to the front in the introduction of new varieties. It is estimated that prior to 1904 some 500 different kinds of canes had been brought from other countries. From 1905 to 1916, 360 new varieties, largely from New Guinea, were introduced to the Mackay Sugar Experiment Station. Of these, a large number have been tested, and canes suitable for distribution have been selected. The methods of selection are to grow the canes over a period of years and over a number of ratoon crops, each variety being analyzed no less than four times in each year, during the months of June to September. Those

showing high percentages of sugar which have proved good croppers, and are absolutely free from disease, are made available for farmers and plantations. Others, light in weight and difficult to cut, being valueless from the farmer's point of view, were discarded, as were others which developed disease. The results obtained from carrying five of the original New Guinea varieties collected by Mr. Tryon, over a plant and five ratoon crops, are summarized in the following table:

No or Name of Variety.	Country.	Total Cane per Acre. English tons (Six crops).	Total Sugar per Acre English tons (Six Crops).
15 (Badila)	New Guinea	270.5	50.2
24	"	255.1	46.3
24A	"	266.7	45.6
24B	"	257.5	42.2
40	"	253.4	38.8

In addition to the varieties introduced from other countries, a large number of seedlings grown from the actual seed in the cane have been raised by the Queensland Acclimatization Society and the Colonial Sugar Refining Company. As is usual in seedling work, very few of these were of commercial value, but a cane known as Hambledon Queensland 426 raised in this way by the Colonial Sugar Company is today extensively grown, and is of high sugar content. At the present moment there are some 40 varieties being grown by cane farmers for the mills, but the standard cane in North Queensland is the Badila previously referred to. In Southern Queensland a seedling cane known as Demerara 1135 is the favorite variety.

SOILS.

The land in Queensland used for sugar growing is included in a long, narrow, coastal belt. Parts of this belt are separated from each other by considerable tracts of non-sugar country. The latter, owing to deficient rainfall or poorness of soil, are not utilized for cane. This belt is included between latitudes 16° and 28° south, and the bulk of the staple is grown within the tropics. Cane soils vary considerably in character and composition. The following classification was made by Dr. Maxwell, formerly Director of Sugar Experiment Stations:

District.	Soils.
Cairns........	Partly shaley sterile soils, but in the main, deep alluvial sandy loams, also rich red volcanic soils.
Mackay......	Shaley in parts, with better alluvia over the lower levels. Mixed volcanic and rich siliceous alluvia.
Bundaberg....	Rich alluvial delta soils, interspersed with sterile soils and deep rich red volcanic soils.

The bulk of the sugar soils can be stated to be from good to rich alluvial, such as river flats and the deep red volcanic soils of considerable depth. The nature of the country is generally designated "scrub" and "forest." The North Queensland scrubs are really jungles, carrying a thick growth of what is known as scrub timber, such as silky oak, bean, pender, kauri, milkwood, Johnstone River hardwood, interlaced with lawyer vine and other creeping plants, while the stinging tree is also conspicuous. Forest country usually consists of ironbark, bloodwood, Moreton Bay ash, bluegum, poplar-gum, and acacia.

The following are average analyses of a number of soils from each of the three sugar districts mentioned:

District.	Lime.	Potash.	Phosphoric Acid.	Nitrogen
Cains.................	.292	.310	.141	.122
Mackay................	.829	.223	.165	.122
Bundaberg.............	.636	.144	.404	.120

RAINFALL.

The Queensland rainfall, fortunately, is highest during the summer period, at which time the cane plant makes its maximum of growth. The following are average rainfalls in the principal sugar-growing districts:

Cairns	92.65
Johnstone River	160.88
Herbert River	84.91
Mackay	66.67
Bundaberg	44.40

Cane grows best when the relative humidity of the atmosphere is high, and this is the case during the wet season in Northern Queensland.

PESTS.

The sugar-cane plant in Queensland is subject to many pests and diseases. The most serious of these at the present time is

the grub pest. The larvae of *Lepidiota* and other scarabaeid beetles attack the roots of the cane, causing the stool ultimately to fall and perish. Thousands of tons of cane, particularly in the north, have been destroyed, and a high price, per lb. or quart, is now paid for the grub and beetle in many parts of Queensland. In Mackay over 15 tons of beetles have been captured within so short a time as two months and destroyed. The weevil borer (*Rhabdocnemis obscurus*) and the moth borer (*Diatraea saccharalis*) do a certain amount of damage, but have not so far called for urgent repressive measures.

Investigation and research work is now being carried out by the Bureau of Sugar Experiment Stations in a systematic way. The Entomological Laboratories are situated at Meringa, near Cairns, which is the center of the worst grub-infested region in the north. The work is in charge of Dr. J. F. Illingworth, formerly Professor of Entomology at the College of Hawaii. Numerous Bulletins dealing with the question have already been published, and work now being undertaken will include:

Morphological study of reproductive organs of beetles, with relation to the period of ovipositing and the number of eggs produced.

Morphological study of the fungus parasites.

Breeding of the various local parasitic and predaceous insects in cages.

Introduction and breeding of beetle parasites from other countries.

Experimental methods for the rapid multiplication and wide distribution of our fungus parasites.

Introduction of bacterial and fungus enemies of the beetles from other countries.

A further study of various light-traps for the beetles.

A further study of repellents.

Field and laboratory experiments in the use of poisons for the grubs.

Field experiments to determine the relation of fertilizers to resistance; using green manure, stable manure, meatworks' refuse, nitrate of soda, etc.

MILLING WORK.

During the past twenty years a great improvement has taken place in mill work and the coefficient work and recovery of sugar is now much more satisfactory, although there is still room for better work. The average tons of cane required to make a ton of sugar has dropped from 9.54 in 1899 to 8.5 in 1914, while in 1915,

owing to the high density of the cane caused by a dry season, it fell to 8.2. Seeing that the up-to-date mills in Hawaii take 9.16 tons of cane to 1 ton of sugar, the above results compare more than favorably with that place. Taking one of the Central Mills (Mulgrave) in the middle of the season, we find the extraction per 100 of sugar to be 94.10 per cent, the recovery from sucrose in cane to be 82.2, the commercial cane sugar in cane 13.7, the tons of cane to 1 ton raw sugar 7.88, and the quotient of purity of the final molasses 37.4. Chemical control is practised in all the sugar mills except those of very small dimensions. The regulation of the price paid for cane is vested in a State Board, consisting of five members, called the Central Cane Prices Board, which fixes the prices for the current season before it commences. Local Boards also sit in the different districts, and if they fail to make an award the matter is relegated to the Central Board.

The best work is done by the Colonial Sugar Refining Company, who inaugurated chemical control in their factories many years ago. Their system is a very complete one, and enables the management to lay its finger quickly on preventable losses. In the north this company frequently turns out 1 ton of sugar for between 6 and 7 tons of cane.

(*d*) COMPARISON WITH OTHER COUNTRIES.

The growing of sugar cane in Queensland compares favorably with other countries when it is remembered that with slight exceptions it is carried on by a large body of small farmers (about 4,000), who do not possess the necessary capital to develop their farms in the same manner that the large millers of Hawaii and Java can do, with the added advantage in the latter island of remarkably cheap labor. Not only is Java blessed with a good supply of labor, but its irrigation works are of great magnitude, and the waters are rich in a silt containing potash and phosphoric acid (stated by Prinsen Geerligs to be quite sufficient for the cane crop), so that only nitrogenous manures are needed. Add to this that the imperative needs of a large native population demand a carefully regulated system of land tenure so that cane is only planted one year in three. This means that there are only crops of plant cane in Java, no ratoons.

In Hawaii enormous sums are spent in irrigation and manures, it being considered that at Ewa plantation alone £14 per acre is expended on the former, which expenditure is estimated to give a return of 3 tons of sugar per acre more. The total capital invested in Hawaii in irrigation plants is stated to be £3,000,000. The crops in Java average about 40 tons per acre, while those of

Hawaii are given at 44 tons of cane and 4.9 tons of sugar per acre, a very fine result. In Queensland in favorable seasons in the north 50 to 70 ton crops of plant cane are common, but the average is pulled down by the want of proper cultivation and fertilizing in some instances, drought and frosts in southern sugar districts, and the ratoon crops. The latter are the canes that grow up again after the plant crop has been harvested, and third and fourth ratooning is practised in Southern Queensland. In the north it is rare to go beyond second ratoons. The cane per acre of recent years has averaged about 20 tons, which is better than it was some time ago. The varieties of cane in Queensland are, as a whole, better than in either Java or Hawaii, as they are higher in sugar percentage. Mill work in the best factories in Queensland is quite as good as elsewhere, but a number of mills require bringing up to date, and their efficiency should be increased. This, at the present time, is impossible, owing to scarcity of freight and the difficulty in obtaining machinery.

(*d*) LABOR AND WAGES.

Owing to the recent awards made by the Industrial Court in Queensland, the Sugar Industry in that State is probably the highest paid agricultural industry in the world. Australia is the only country in the Globe that is attempting to grow cane sugar with white labor, and the experiment is an interesting one, not only to ourselves, but to other sugar producing countries, because (as Dr. Maxwell pointed out in 1905 in a report to the Commonwealth Parliament) "it traverses natural and economic conditions that have to be consulted at every step." It is noteworthy that seven years after this was written the Federal Royal Commission upon the Sugar Industry stated there appeared to be no reason to doubt that white laborers can satisfactorily perform all the work of the sugar fields, and that was a view founded upon accomplished facts.

It must be admitted that so far the employment of white labor has meant a great increase in the settlement and prosperity of the Queensland coastal towns, such as Bundaberg, Mackay, and Cairns. The kanakas were of little value to the towns, their wages and wants were small, and their standard of living low. Work in the cane-fields such as hoeing is now paid at the rate of 1s. 5d. per hour in the south to 1s. 7d. per hour in the north, or 11s. 4d. to 13s. per day of eight hours. Cane-cutters during the season are paid from 15s. 6s. per day in the south to 16s. 8d. in the north. The bulk of this work, however, is done on contract, and cane-cutters receive 6s. 3d. per ton for crops of 15 tons per acre and over in the south, and 6s. 9d. for the same tonnage in

the north. Good cane-cutters can earn up to £10 and £12 per week at these rates. Overtime is paid for at the rate of time and a half, and Sunday work is at double rates. Twelve days are specified as holidays, on which overtime rates have to be paid. Since 1912 wages have increased 60 per cent in the industry. It is only in a year like the present, when crops are exceptionally good and the price of sugar is higher than ever before, that farmers can hope to pay such rates. Labor is stated to represent about 70 per cent of the cost of the production of cane. It is, however, generally recognized that the payment of a fair and just rate to laborers is essential, and that it makes for increasing efficiency. No grower of cane begrudges this to labor so long as he obtains such a price for his product as will enable him to pay it and the laborer puts in a fair day's work. The greater portion of the cane-cutting is carried out by seasonal labor obtained from New South Wales, Victoria, and Tasmania, and the cutting season lasts from four to six months.

(*f*) HEALTH IN THE TROPICS.

The Federal Royal Commission stated in their report that they entertained no doubt as to the possibility of effective settlement by a white population of the Queensland coastal areas. The present population is a normally healthy one, with a fully developed physique, and a low death rate. In evidence given before the Commission, the head-mistress of the State school at Mossman stated: " . . . . the general standard of health and physical standard here are as good or better than they were in the west. . . . . The attendance is better than on the Darling Downs. Only two children who have been in attendance at the school have died since I have been here (13½ years). . . . . Neither of them was born in the district."

Dr. P. H. Clarke, Government Medical Officer at Port Douglas, stated, *inter alia*, "that cases of sunstroke were rare; that epidemics were attended by a lower mortality than in the southern portions of Australia; that, with proper care, the probability of children born in the district living to adult ages was greater than in the southern portions of Australia; that the most prevalent cases of tropical complaints were preventable."

The opinion held by medical men is that the white man can lead a healthy life and rear a vigorous family in tropical Queensland provided he adapts himself to his surroundings as regards diet and clothing and avoids alcoholic excesses, which are debilitating in the tropics, and a fruitful cause of sickness amongst the workers in the Sugar Industry.

The effect of the Northern Queensland summer climate is

more enervating in respect to women than men, and they require more frequent changes, while conditions should be rendered fit for white women. Dr. Maxwell, in his report to the Federal Government, said: "The white woman is rendering a tribute in populating and settling the north, which commands the greatest praise, but also the gravest concern; and whatever of the nature of alleviation can be brought in or retained in the form of domestic aid to lessen the physical strain put upon her by the climatic situation, should be done even if it is done for no higher than economic reasons."

The winter climate of Northern Queensland is delightful, while the southern parts are cold and frosts are often experienced. At the back of Cairns is the invigorating Atherton Tableland, which is within an hour or two by rail from the hot moist seaboard, and which affords to coastal residents a complete change.

(*g*) UTILIZATION OF MOLASSES.

The chief source of waste in sugar-mills is that of molasses. It is estimated that more than one-third of the total output is run away. In the last report of the Government Statistician of Queensland, he gives the figures for 1916 as under:

Total quantity recorded..........	6,432,439	gallons.
Sold to distilleries and others......	818,812	"
Used for fuel..................	433,500	"
Used for manure................	54,600	"
Used for feeding stock..........	1,439,108	"
Held in tanks at mills..........	797,084	"
Balance run to waste............	2,799,335	"

Approximately 11,000,000 gallons have been wasted during the past five years, and he says that the quality shown as run to waste would be very much larger if all mills furnished full details of their production.

The Commonwealth is establishing a factory on the Brisbane River to treat molasses and lime with a view to making acetate of lime. This will be afterwards converted into acetone, which is used in the manufacture of cordite.

This amount of molasses run to waste opens a field for enterprise if the freightage costs from the mills can be overcome, and is one that might be profitably discussed by this Conference. Proposals have been made for its conversion into motor and industrial spirit, but nothing concrete has yet been done.

(*h*) PRESENT DAY PROBLEMS.

Queensland expects to produce this year upwards of 300,000 tons of sugar, which will be far in excess of the yield of any pre-

vious year and of the Australian consumption. No doubt this could be profitably exported in view of the high rates for sugar ruling in Great Britain, but for two reasons. The first is that an embargo has been placed on export, and, secondly, if this were removed it is doubtful if bottoms could be obtained in which to ship the surplus. This will probably, therefore, have to be held by the Commonwealth to make up for a possible shortage next year. The most acute problem facing the Queensland Sugar Industry today is its uncertainty. If a fair price is maintained the industry will go on. If not, it is doomed to failure. After the war, when huge stocks of sugar are released, there will be a slump in the world's prices, and the southern people, overlooking the national importance of the Queensland Sugar Industry, may clamor for cheap sugar. If Australia is going to keep the Queensland Sugar Industry for the white races, it must be prepared to pay such a price for sugar as will enable this to be done. The Federal Royal Commission said, "a white community which prefers to grow its own sugar in its own territory with white labor must face the responsibility of making good the increased cost of production under the higher standard of living and reward. Either the consumer or the taxpayer must pay."

These difficulties, which are only lightly touched on here, are having another effect in some northern sugar districts. They are leading to a determination on the part of certain Queensland cane growers to get out of the industry, and the opportunity to do this is being given them by the keen desire of Italians and other foreigners to become possessed of sugar farms. In given localities in the north, principally the Johnstone and Herbert Rivers, the proportion of foreign labor is from 75 to 90 per cent, the Italian nation being the most largely represented. It is principally from this latter class that the offers to buy cane farms are coming. Their methods are for several of them to put their earnings together and pay a deposit on a farm, and then to place one of their number in to run it. The remainder go on working in the canefields until they have saved enough to pay a fresh deposit, when another Italian goes in. It is perfectly safe to say that 99 per cent of the sales of cane farms upon the Herbert River recently have been made to Italians, whose standard of living is very much lower than that of our own race. Thirty per cent of the total farmers on this river are stated to be of Italian nationality. At Mourilyan 26 out of 80 farms are in their possession to date, and they are also acquiring farms on the South Johnstone.

(*i*) THE NATIONAL IMPORTANCE OF THE QUEENSLAND SUGAR INDUSTRY.

The Royal Commission upon the Sugar Industry appointed by

the Federal Government made use of the following pregnant words in their report:

"The problem of the sugar industry today is not, save in subordinate respects, a problem of industry, of wealth, or of production; it is primarily and essentially a problem of settlement and defense. No nation can afford to regard lightly the development of its industries, the progress of its wealth, or the economic efficiency of its productive machinery. But, important as these things undoubtedly are, they rank, as regards the sugar industry, on an inferior plane. The Commonwealth today is brought face to face with one of the gravest problems that has ever taxed the ingenuity of statesmanship—that of the settlement of tropical and semi-tropical areas by a white population living under standard conditions of life. And intimately associated with this problem is the question of national defense.

"If the ideal of a White Australia is to become an enduring actuality, some means must be discovered of establishing industries within the tropical regions. So long as these regions are unoccupied they are an invitation to invasion as well as a source of strategic weakness. Granted so much, it follows that the supreme justification for the protection of the sugar industry is the part that the industry has contributed, and will, as we hope, continue to contribute to the problems of the settlement and defense of the Northern portion of the Australian continent. The recognition of the nature of this supreme justification is the first condition of a sound public policy in relation to the sugar industry. Relatively to it all other issues are of minor importance."

This statement as to defense has been justified by the fact that one in eight of the entire population of Mackay have enlisted to defend our country, over 3,000 have enlisted in Bundaberg—a similar proportion, and about the same proportion in Cairns. Had the rest of Australia enlisted in the same ration we should have had over half-a-million men. As an instance of what can be done in settlement by the establishment of a mill in a new district, we may take the example of the recently erected factory at South Johnstone. Three years ago this locality was tropical jungle, now there is a large mill capable of treating 150,000 tons of cane, a township containing school, postoffice, railway station, boarding-houses, picture shows, and upwards of 100 farmers settled on the land growing cane.

It was further pointed out by the Royal Commission that, as a result of the increase of the white population on the Queensland littoral, a new stimulus had been offered to the opening up and settlement of large inland areas at an elevation above sea-level.

After considering the necessity for erecting further mills in

Queensland last year a Board, of which the writer was a member, said in its report to the Government:

"The settlement of our northern littoral appears to be indissolubly linked up with the expansion of the sugar industry. There is no present prospect of the establishment of any other industry on a considerable scale. Of rich tropical lands awaiting development there are large areas. The importance of the industry as a means of settling these lands and as the source of abiding wealth to the community cannot be overstated; and, if this work is to be carried out, those engaged in the industry are entitled to expect and to receive the most sympathetic consideration from the people and Government of the Commonwealth.

"It is beyond dispute that the expansion or even the continuance of the greatest agricultural industry in Queensland is impossible in the face of a hostile or apathetic public in the Southern States.

"If we are to judge by the action since the commencement of the war of the Price-fixing Boards appointed by the Governments of New South Wales and Victoria—which in 1914 represented the two great political parties—public opinion in those States is not yet alive to the national importance of encouraging the industry. In 1914, taking advantage of a temporary fall in the price of sugar just prior to the declaration of war, these Boards fixed the wholesale selling price of refined sugar at £21 per ton, regardless of the fact that this was much lower than the average price of the previous three years."

The consequence to the industry of this action of the two Boards was thus dealt with in the writer's Annual Report of the Bureau of Sugar Experiment Stations in 1914:

"It was found that the Queensland production of sugar, instead of being stimulated and encouraged, was being retarded by the unduly low price fixed by the Southern Control of Prices Boards in those centers of population where the bulk of the staple is consumed. This led, in many cases, to mills making an absolute loss on the season's operations, and forbade the farmer obtaining that increase in payment for his cane to which he was justly entitled in order to meet the higher cost of production and the increase in the cost of living. This happened at a time when the price of sugar had been materially enhanced in the other sugar-producing countries, particularly in those employing cheap colored labor. It was a position directly antagonistic to the white-labor ideals of this country and the national view of settling the Northern littoral, by means of the sugar industry, for defense purposes."

The Board went on to say:

"It was only by putting into operation the Sugar Acquisition

Act of 1915—a purely war measure—that the Government of Queensland were able, with the assistance of the Commonwealth, to acquire the whole crop at a price which, though considerably lower than the world's parity, yet secured to the miller and the cane-grower a better return than was possible under the price fixed by the Southern Boards, without at that time increasing the cost to the small consumer. Even now sugar is obtained by the consumer for much less than the price that is being paid elsewhere, with the single exception of New Zealand, which imports black-grown sugar from Fiji duty free.

"The co-operation of the Commonwealth Government in this transaction is proof that the National Government may be relied upon to take a wider and more national view of the question than the Government of States in which sugar is not produced to any considerable extent.

"With the close of the war the Sugar Acquisition Act of 1915 will automatically lapse, but price-fixing by Government Boards may continue, and, unless there is some agreement come to by the various Governments concerned, the Queensland sugar-growers and millers—and the latter include the Queensland Government—again will be at the mercy of Southern consumers. Any slight pecuniary benefit to the Southern people would be dearly bought if the effect were to jeopardize the prosperity or the very existence of the Queensland industry and drive a national product out of competition in the Australian market.

"But it is not so much such action—which would be in direct conflict with that federal spirit which is supposed to animate the people of every State—that we have to fear as the insufficiency of the import duty. The present price of raw sugar can only be maintained, after the return of peace, by Commonwealth cooperation."

The import duty is at the very foundation of the stability of the industry. The President of the Australian Sugar Producers Association in giving evidence before our Board said:

"But for the home production in Australia we should at present prices have to send £7,000,000 to countries which would take practically nothing from us in return. That is a very large sum in one year, and if you multiply it by a few years, it is not very long before it amounts to £50,000,000, and if this country were £50,000,000 poorer, it would make a very big difference to the general prosperity of the whole of the Commonwealth. It is generally estimated that the sugar industry, directly and indirectly, in Queensland supports 100,000 persons, or one-sixth of the population, and any one can see that if the industry were to go to the wall it would mean the disruption of the whole industrial fabric I do not think it is possible to over-estimate the im-

portance of the sugar industry to this State or to the Commonwealth, because there is no doubt that without it, it would be impossible to settle our tropical areas, and the day may come—we do not know what the future holds for us—when we shall have to prove our title to our tropical lands, and the only title under certain conceivable circumstances that would be accepted would be its effective occupation. That is taking a very wide and high point of view, but still we do not know what eventualities may arise, and we have to be prepared for them. The only way in which we can assert our title to this grand country is by occupying it effectively, which, of course, means making use of it."

As showing what the industry means in the distribution of wealth, the following statement was prepared by Mr. Gibson, one of the owners of Bingera Sugar Plantation:

"I claim that the industry requires the utmost consideration from our legislators, in view of its great value to the Commonwealth. The following statement shows what one plantation and sugar mill means to the public in trade: Revenue to railway per annum, £7,000; shipping company freights, £6,500; harbor dues and wharfage, £1,000; firewood cutters, £2,000; merchants' accounts, £13,000; foundry, £4,000; saw-mills, £1,500; cattle purchased for beef, £5,000; horses bought, £1,500; corn, £3,500; other produce, £1,000; lime, £300; flour, £1,500; coal, £1,000; wages, £45,000; cane cutters' contracts, £21,000; railway lines, permanent, 22 miles 2-ft. gauge, 8½ miles 3 ft. 6 in. gauge; portable, 10 miles 2-ft. gauge; locomotives, 6; increased value of land to farmers by railway and river bridges past six years, £10,000."

The crop this year in Queensland will, if it be all cut, be worth about £7,000,000, at £21 per ton for raw sugar, and about £9,500,000 for the refined marketable output.

Summarizing the foregoing, it is evident that the present uncertainty as to the future of the Sugar Industry should be removed, and a well-considered scheme evolved which would have the effect of retaining the present white population in the coastal districts, and adding to their number as the increase in the consumption of the staple warranted. To the writer's mind, a recommendation of the Royal Commission was a good one:

"That the Customs duty on sugar, raw and refined, should fluctuate in accordance with foreign market prices—falling as those prices rise, rising as those prices fall."

If the present high cost of production is to be maintained in the Sugar Industry, then the measure of protection afforded will need to be adequate.

(*j*) POSSIBLE EXPANSION OF THE INDUSTRY.

Although Queensland may produce a surplus of sugar this year, she has only once before in recent years been within measurable distance of the consumption of Australia. This was in 1913, when 242,837 tons were produced, making with the New South Wales production 265,000 tons, or equal to the then consumption. This is at the present time considered to be 265,000 tons, or 114 lbs. *per capita*. Owing to climatic drawbacks, however, a full season is impossible every year, and moreover the consumption of sugar is stated to be increasing at the rate of 5,000 tons per annum. If the industry be placed on a sound footing and the remainder of the rich tropical lands developed by sugar growing, the question may arise as to the disposal of surplus sugar when made. There are estimated to be 500,000 acres of land in Queensland upon which cane could be grown; at the present time there are roughly 167,000 acres under cane.

Two suggestions regarding exportation of sugar have been made both of which are somewhat visionary:

(*a*) Imperial Federation, which would protect sugar grown within the Empire by levying duties against outside countries; and

(*b*) Payment of an Export Bonus by the Commonwealth or raised by a tax upon the Australian consumers of sugar.

A conference was called last year by the British Empire Producers Association, at which the Australian industry was represented by Mr. G. H. Pritchard, Secretary to the Australian Sugar Producers Association. The Conference framed an Empire sugar policy by recommending preferential treatment with total prohibition of enemy sugar for five years, and thereafter a 50 per cent surtax. At no time should the difference between enemy sugar and Empire sugar be less than 1d. per lb. It is difficult to see how these recommendations would help the Australian production of sugar under white-labor conditions, although a suggestion has been made that all Empire sugar should be pooled, when the higher price of the small quantity of Australian sugar would only slightly affect the price of the whole Empire sugar to the British consumer.

PART II.—BEET SUGAR.

I do not propose to deal at any length with the Beet Sugar Industry, because it has not for one moment the same claim on Australia from the national standpoint as the Queensland cane industry, and it is for this reason that I have said nothing about

the cane industry in New South Wales. Both these States are comparatively thickly populated, and if cane or beet growing were discontinued it would make very little difference to the population. If the cane industry in Queensland were to collapse the northern coastal areas would speedily become depopulated, and the ruin of several fine northern towns would be accomplished. As long as sufficient sugar can be produced in the tropical areas of North Queensland, there is no need for any special encouragement of sugar beet growing in other parts of Australia, important as it is an agricultural industry from the standpoint of intensive culture, rotation, and the feeding of cattle.

For the present then the beet sugar question can be very well left to the demonstration being made at Maffra, as it is not likely that private enterprise will provide capital for beet sugar growing until it is proved that the industry will be a payable and successful one. The Federal Royal Commission previously quoted went further than this, and said that if its advocates were right as to the relative economic efficiency of the beet industry, encouragement by the Commonwealth must imperil the very existence of an industry which has been built up at a great expense to the Commonwealth and the State of Queensland, and which, as a contribution to the solution of the problems of tropical settlement and defense, serves purposes of which the importance to our national life can scarcely be exaggerated. They recommended, therefore, for consideration whether it would not be advisable to pass an Excise Act imposing a special Excise of £2 per ton on the manufacture of sugar from beet in any year when the total output of beet sugar within the Commonwealth shall exceed 10,000 tons. Before concluding this paper, a very brief account of the industry in Victoria may be interesting.

The history of the beet sugar movement in Victoria has been rather an unfortunate one up till quite recently. Before the establishment of the Maffra Factory attempts were made to grow beet at Anakies, near Geelong, and a factory was actually built at Rosstown which never operated. The erection of the Maffra Factory was the result of an "Act to encourage the establishment of the Sugar Beet Industry in Victoria." Money was lent by the Government, and operations were commenced in 1898. At the end of the second season the factory shut down, its two campaigns having proved unsuccessful for lack of beets. The Government foreclosed on its security, and the factory remained idle for some eleven years. The Government then reopened the building, and it has since 1911 been working, for the first years at a loss. Last season 15,159 tons of beets were cut, less than half the capacity of the factory, which is a fine one. This yielded 1,948 tons of white sugar. The acreage harvested was 1,320.

After paying all expense, including interest and depreciation, a profit was made of £8,013 13s. 2d., which is decidedly the best result to date. Unfortunately, the beet industry in Australia has to depend on foreign countries for its seed, and there has been some difficulty experienced this year, which will probably cause a loss of acreage for next season.

The two difficulties experienced in the Maffra district are (*a*) climatic conditions and (*b*) want of interest by the farmers. Even at the present time there are comparatively few farmers growing beet, and a large part of the supply is from one large estate which is rented out to smaller growers who have no land available of their own. This is quite contrary to the European practice of improving one's own land by the growth of sugar beet.

The benefits to be derived from growing beets are patent. It encourages closer settlement, and, like the cane industry, causes large sums of money to be circulated in the payment of wages and purchase of materials. It considerably enriches the land and the pulp produced is exceedingly valuable in stock raising. Australia, however, must develop her unoccupied spaces first, and when this is accomplished, and the needs of Australia demand a greater sugar production, the beet industry will find room for its establishment.

DISCUSSION OF MR. EASTERBY'S PAPER.

Prof. Watt thought that Mr. Easterby had made out a very good case for giving special encouragement to the Queensland sugar-cane industry. In New South Wales, the growing of beet-sugar had not been attempted, as the general opinion was that sugar could be produced more profitably from cane than from beet. The sugar-cane industry in New South Wales was founded at Port Macquarie in the very early days, and, though it extended considerably in the Northern District, it had latterly tended to recede. This was due to the discovery that Paspalum would thrive on the sugar-lands, and that the growing of this grass for dairying was more profitable than cane-growing. From the analyses of soils given by Mr. Easterby, he judged that in Queensland, as in New South Wales, sugar-cane was only grown on rich soils, and he could not suggest any crop that could take the place of sugar in Northern Queensland if conditions made cane-growing unprofitable.

Dr. S. S. Cameron, Director of Agriculture, Victoria, speaking by invitation of the Chairman, said that he hoped the Con-

ference would not found any conclusions based upon what Mr. Easterby had said concerning the beet-sugar industry. He understood that Mr. Easterby thought that at present beet-growing should be confined to Maffra, on the ground that for defense and economic purposes the growing of sugar-cane in North Queensland was essential to Australia. He did not propose to discuss questions with a political bearing, but intended to confine his remarks to the industrial and commercial aspects of beet-growing. The industry at Maffra had had a most unfortunate history. The factory was established and staffed largely by Germans in 1898, and then, as now, the Germans seemed to have no idea of handling Australians successfully. After two years the company went into liquidation, and the Government, as the largest creditor, took possession of the factory. In 1911, the factory was re-opened by the Government, and he admitted that until quite recently the results had been discouraging. Mr. Easterby had attributed this to two causes: (1) the climate, and (2) indifference of local farmers; but he contended that the second cause was directly dependent on the first. The factory was in a most unsuitable locality and situation, since beet required summer rainfall, and Maffra was in a dry region with winter rainfall. Whenever rain had fallen in the summer, however, the beet crop had been a success. It must be remembered that the factory was financially handicapped by having to pay interest and depreciation on capital accumulated during past years, and hence it was only this year that an actual profit had been shown, though during the three previous years there had been a profit on the manufacturing operations themselves. This year the profit was £8,000—really, £9,500, since £1,500 had been spent on securing seed for next year's crop.

He maintained that beet-sugar growing was a natural auxiliary to dairy-farming in temperate climates, especially where condensed milks were manufactured. The refuse from the beet factory was a valuable stock food, whilst the sugar produced could be used in the condensed milk factories, and thus obviate the payment of large sums for freight on sugar brought from Queensland. He did not think the State should do more than establish one factory as an object lesson, but he thought if that proved a success other factories would spring up in different localities as a result of private enterprise. The cost of a factory turning out 4,000 tons of sugar, or treating a 40,000-ton beet crop, was from £60,000 to £100,000 in normal times; though at present it would be greater. The most economical plan was to keep the factory running till the whole crop for one season had been treated. This meant running it for three months, or, under Australian conditions of climate, it might be from February to

July. In that case, a factory regarded as a 40,000-ton factory could treat 50,000 or 60,000 or more tons.

The success achieved last year might, perhaps, be attributed to the higher price of sugar, £27 to £28, as against £20 in normal times, but, as against that, the price paid for beets had been increased from 20s. to 27s. 6d. a ton, and the cost of manufacture had also increased. Under Australian conditions he thought beet could be grown more cheaply in large areas, where its cultivation could be undertaken by mechanical means, other than by peasant labor on small holdings, as was the practice in Europe.

The sugar content averaged from 16 to 17 per cent, but in dry seasons it was higher, even up to 27 per cent; whilst in good seasons there was a larger yield with a lower sugar content. An extra 1s. per ton had been paid for every extra 1 per cent over 15 per cent when the 15 per cent beet was being bought for 20s. per ton. In extraction there was a loss of from 3 to 4 per cent of sugar. This year they averaged over 12 per cent; that is, they got over 12 tons of sugar in the bags from every 100 tons of beet.

Prof. Paterson said that it was evident that the technical problems connected with sugar-growing were being very efficiently investigated in Queensland, and it did not seem necessary for the Commonwealth to take any action in this direction. The problems connected with sugar were mainly of a political and military character, with which the Conference was not called upon to deal. The present high duty on imported sugar had been imposed in order that sugar-growing in Queensland might be made profitable, and the reasons why it was desired to make it profitable were military and political. If, then, the development of the beet-sugar industry in the southern States rendered sugar-growing in Queensland unprofitable, the original reasons for imposing the duties on foreign sugar would cease to exist, and he thought it doubtful if the consumers would consent to the continuance of the high duties in the interest of Victorian beet-sugar growers. He would like more information as to whether sugar could be produced more cheaply from sugar-cane or from sugar-beet.

Mr. Easterby said that, under present conditions, he thought sugar could be produced more cheaply in Queensland than in Victoria. Dr. Cameron had evaded the main issue, which was that farmers in Victoria could grow other crops profitably, whilst in Queensland, if the sugar industry collapsed, they could grow no other crop profitably. In that case a vast territory would revert to jungle, and considerable towns all along the Queensland coast would disappear. The Commonwealth had appointed a Royal Commission, which spent a year making careful inquiries, and he had quoted their main conclusions in his paper.

Dr. Cameron said that the great development of the beet-sugar industry in recent years indicated that it was a cheaper source of sugar than sugar-cane. The cultivation of beets was of great advantage in enriching the land. Even if sugar could be produced as cheaply in Queensland as in Victoria, it would obviously be a great advantage to the condensed milk industry to have both milk and sugar produced in one district.

Mr. Easterly said that some years ago more sugar was produced from beets than from cane, but during the last eight or nine years the position had been reversed, and some millions of tons more sugar were now obtained from cane than from beets.

Prof. Perkins pointed out that beet-growing did not seem attractive. Dr. Cameron had said that the cost of production in Victoria was from £10 to £12 per acre, the average yield 8 tons per acre, and the price paid to the grower £1 per ton. Under these circumstances, he could not see where the profit came in. He thought that if beet-growing was a really profitable industry it would be impossible to hinder it; but that though Victoria had a perfect right to do so, it did not show a Federal spirit in encouraging an industry which was not very profitable and which was likely to damage an established industry in another State. He thought that a very strong case would have to be made out before he would be justified in recommending the expenditure of £100,000 for the establishment of a beet factory in South Australia; and when he found that after all these years only about 1,000 acres was under beet in Victoria, he did not think it was promising. He thought that it was inevitable that beet-growing would require more labor than most Australian farmers could give it, and it was more on a level with potato-growing than with the standard agricultural crops. Under these circumstances he thought the Queensland cane-sugar industry should not be interfered with, but rather should be encouraged.